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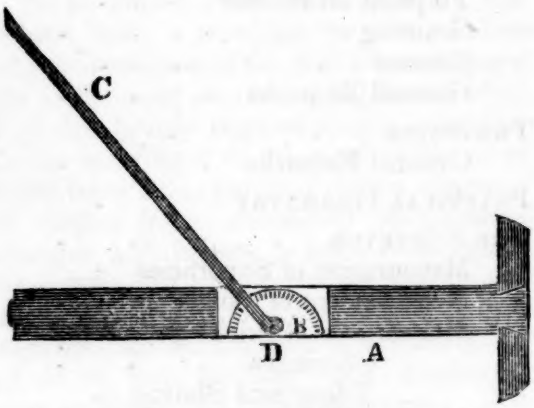

To the Editor of the Mechanics' Magazine.

SIR,—I send you an improvement of Dr. Farishes Isometrical drafting square, as published in Brantons Machanics', page 209; should you think it worthy your attention you will please give it place in your valuable Magazine, that it may benefit some who are making use of his perspective.

In the first place take a common drafting square A, with the blade something wider than usual, and (instead of his notched ruler so made as to form an angle of 60°, which he says is the most common angle,) put a piece of Brass B, so fitted as to slide from end to end. On that strike a semi-circle, graduato it into 180°, numbered from the base upwards to 90°; then by another small ruler C, turning on the point D, in the centre of the circle and one side running directly to it; it will readily be seen that we may draw a line to any angle by taking the degrees on the circle instead of being confined to one, as in his plan. I made one, only temporary, but am satisfied that it may be made so as to be a great improvement in Isometrical Perspective. H. B.

BUILDER'S MANUAL.—The importance to the community, of a correct knowledge of building, induces us to re-publish in the Magazine "the *Builders Pocket Manual*, containing the elements of BUILDING SURVEYING, and ARCHITECTURE, with practical rules and instructions connected with the subject, by A. C. SMEATON, civil Engineer."

This work will be found highly useful especially to young builders, as it describes and illustrates by engravings, the various modes of building. There are over 75 engravings. By the following "contents" our readers will perceive the character of the work. It will be completed in the six ensuing numbers.

CONTENTS.

INTRODUCTION.

So intimately is the art of building connected with a provision for the comforts and conveniences of life, that it has engaged the attention of men from that period when they first formed themselves into societies. In the early ages of the world, little more could have been required than a temporary shelter from occasional atmospheric changes, and houses or huts were probably constructed in a very rude and imperfect manner; but as even communities were not then accustomed to confine themselves to any locality, such residences were sufficient for their purposes. But when large societies determined to occupy a place as a constant residence, they surrounded themselves with all those permanent comforts which might be within their reach. The art of building necessarily attracted much of their attention, and nations vied with each other in an attempt to blend stability of structure and elegance of appearance. These are the objects of builders in the present day, but at the same time, the altered state of society requires that they should be equally careful to secure economy in the use of the materials, that no unnecessary expense may be incurred by their waste or misapplication, or by the addition of unnecessary labor.

The importance of the subject has induced men to acquaint themselves with the general principles of construction, and the application of ornament; and to give their attention to individual branches of the science and art of building, so as to obtain by the combined labors of many some knowledge of the whole. Many expensive and useful books have been published, by both architects and builders, upon different subjects connected with the art and science of building; but many of these books are not only too costly for the means of some persons desirous of knowledge, but would be almost useless if they could be obtained. A preliminary knowledge is required before the student can either perceive the importance of the information they contain, or the means by which it may be applied. There are it is true, many introductory books, but they chiefly treat of Architecture and Designing, and are of little assistance to the workman or the student.

In preparing this manual the author has endeavored to supply the reader with such important elementary knowledge as shall enable him to understand the general principles of building, and fit him for the perusal of those works which have been written on several subjects connected with the art. There are three classes of men engaged in the completion of a building, the architect, the builder, and the surveyor; and each should be perfectly acquainted with the business of the others. Some persons have professed the three arts, a practice which cannot be too strongly condemned, since it is impossible that any man can give sufficient attention to all. to do either correctly or well. But at the same time an acquaintance with all is desirable, for they are so closely connected, that one cannot be properly practised without the assistance of the others.

The business of the Architect is to design buildings, to make such drawings, and to so describe them as shall enable the builder to execute that which he has planned. The surveyor masures the work when finished, and affixes appropriate prices according to his judgment of the manner in which the workman has performed his task, and the difficulties which have attended the execution. An elementary work on Building should describe the manner in which these persons severally perform their tasks, and we have therefore divided our book into three parts or sections, which we have designated the Builder, the Surveyor, and the Architect.

THE

BUILDER'S MANUAL.

THE BUILDER.

Writers on Architecture have frequently divided the art into three parts, because in the erection of a building three things are required, *strength*, *convenience* and *beauty*.

In order to obtain strength, good materials must be employed, and they must be well applied. There must be a proper arrange-

ment of the several portions of edifices, so that instead of weighing down or oppressing each other, they may mutually strengthen each other; and should faults be suspected to exist, in either the quality or dimensions of the materials used, they must be employed where they would be sufficient for the purpose, should the suspicion be realized. The builder must also be careful that any stress may be met by a suitable arrangement of parts, and that the strength may be in a reciprocal proportion to the stress which is to be overcome.

To provide convenience, the building must be suited to the purpose for which it is intended. The rooms, for instance, should be of a size proportionate to the use for which they are to be employed, or the business that is to be done in them; a small house should not be encumbered and lessened with a large staircase, nor a large mansion be rendered uncomfortable by one that is cramped in its dimensions. "The hall," as Fuller says, "ought to lie open, and so ought galleries and stairs, provided the whole house be not spent in paths. Chambers and closets ought to be private and retired." Every part should be suited to the purpose for which it is to be used.

The beauty of a building does not altogether depend upon its architectural decorations and ornaments; but there must be a just proportion of all its parts, the width, length, and height, being everywhere so adjusted as to produce that harmony calculated to give pleasure to the observer. Many persons err in overloading an edifice with ornament, while others impair the general appearance by neglecting altogether its enrichment. There should never be introduced an ornament that has the appearance of supporting a weight where there is evidently no weight to support; and when mouldings are employed, they should have an agreement with the dimensions of the walls on which they are to be fixed, being neither heavy in small apartments, nor diminutive in large ones.

The first thing to be done when a building is to be erected, is to survey the ground on which it is to be placed, with a view to determine the nature of the soil, whether it be rocky, swampy, or composed of clay, gravel, or sand. When this has been determined the foundations may be arranged for, and the operations required must be regulated accordingly.

The dimensions must then be set out, as shown upon the plan of the basement. This is best done by first marking out the line of the principal front, and then placing stumps, or pins, at those parts where the side and internal walls meet it. When the several angles have been determined, and the line of walls marked out, the excavator may proceed to form the trenches which are to receive the footings, or foundations; and the work is then regularly proceeded with, according to the drawings which are placed in the workman's hands. And here it may be necessary to remark, that architects generally form their drawings from a scale of one eighth of an inch to a foot; but this is not adopted in every case; and, therefore, to prevent mistake, the plans and elevations are generally figured. The scale of one inch to a foot is the most convenient for workmen, for they have then only to apply their rule to the several parts of the drawing, and, calculating every inch as a foot, it is scarcely possible for them to make a mistake. But it is not always practicable to draw a plan to this scale, as it would in some instances extend the drawing to an inconvenient size.

These general remarks may be of some service to the beginner, as illustrating the objects to be obtained in building, and the manner in which the workman is to commence his operations. We may now proceed to make some more particular remarks upon the several departments of building, the nature and composition of the materials employed in each, and the methods by which they are worked. As this little volume is intended for the use of the student in all departments, we shall not consider any fact, however self-evident it may appear, too simple to be mentioned; but we shall endeavor to lead him on, by easy steps, from the simple to the more complex principles of the art, giving so much of the science as may appear necessary to afford a reason for the process that may be adopted.

THE BRICKLAYER.

As the art of bricklaying is generally supposed to be so simple as to require little or no attention, it will be necessary to remove this false impression by a somewhat particular detail of the facts which relate to it. There are many persons, and even some

workmen, who suppose that nothing more is required than that the bricks should be properly bedded, and the work level and perpendicular. But the workman who would attain perfection in his business, should acquaint himself with the different arrangements made use of in placing the bricks, so that one part of the work shall strengthen another, and thus prevent one portion from a greater liability to give way than another. It is also necessary that the workman should be acquainted with the several sorts of bricks, their qualities, and the uses for which they are particularly adapted.

It appears from history that bricks have been employed for building from a very early period. We are informed by the sacred records, that very shortly after the occurrence of that universal catastrophe, which swept from the earth nearly the whole human race, and remodelled its surface, the sons of Noah fixed their abode in a plain in the land of Shina or Chaldea, "and they said one to another, go to, let us make brick, and burn them thoroughly. And they had brick for stone, and lime had they for mortar." By the same authority we are informed that the Jews during their servitude to the Egyptians, were employed not only in making bricks, but also in building with them. "And they (the Egyptians) made their life bitter with hard bondage, in mortar, and in brick."—"And they built for Pharoah treasure cities, Pithom and Raamses." Nearly all the Egyptian buildings spared by the devastating hand of time, are constructed of stone, but there are some brick buildings still in existence, and Pocock mentions a pyramid constructed of unburnt brick.

From all the evidence we can collect on the subject, except that to which we have referred, it does not appear that the Egyptians, or any other of the early inhabitants of the earth, were acquainted with the art of burning bricks; but both the Greeks and Romans used them. Vitruvius has given a description of the kind of bricks used in his own day, and has offered some suggestions as to the choice of the material from which they ought to be formed. The passage is interesting, as and the works of this author may not be in the possession of all our readers, we may be permitted to quote it from Mr. Guilt's translation. "They should be made of earth of a red or white chalky, or a strong sandy, nature. These sorts of earth are ductile and cohesive, and not being heavy, bricks made of them are more easily handled in carrying up the work. The proper season for brick-making are the spring and autumn, because they then dry more equally. Those made in the summer soltice are defective, because the heat of the sun soon imparts to their external surfaces an appearance of sufficient dryness, whilst the internal parts of them are in a very different state; hence when thoroughly dry, they shrink and break those parts which were dry in the first instance; and thus broken, their strength is gone. When plastering is laid and set hard on bricks which are not perfectly dry, the bricks which will naturally shrink, and consequently occupy a less space than the plastering, will thus leave the latter to stand of itself. It is not therefore, without reason that the inhabitants of Utica allow no bricks to be used in their buildings, which are not at least five years old, and also approved by a magistrate.

"There are three sorts of bricks, the first is that which the Greeks call Didoron, being the sort we use, that is, one foot long, and half a foot wide. The two other sorts are used in Grecian buildings; one is called Pentadoron, the other Tetradoron. By the word Doron, the Greeks mean a palm. That sort which is five palms each way is called Pentradon; that of four palms, Tetradoron. The former of these two sorts is used in public buildings, the latter in private. Each sort has half bricks made to suit it, so that when a wall is executed, the course on one of the faces of the wall shows sides of whole bricks, the other face of half bricks, and being worked to the line on each face, bricks on each bed bend alternately over the course below."

There has been some dispute among antiquaries as to the time when bricks were first introduced into England. Dr. Lyttleton states in Archæologia, that there were no brick buildings earlier than the fourteenth century. Bagford says they were introduced in the reign of Henry the Seventh, but it must have been earlier than this, for Ewelme palace in Oxfordshire, erected by William de la Pole, and Herstmonceaux castle in Sussex, were both erected in the reign of Henry the Sixth. But we leave the antiquaries to determine this disputed question, and proceed to make a few remarks of a more practical character.

Bricks.

Brick is an artificial stone, formed of

clay moulded in rectangular prisms of constant dimensions, and hardened by burning, or exposure to the sun. All bricks made in England must be, according to act of parliament, nine inches long, four and half inches broad, and two and a half thick.

There are several kinds of bricks; the most important to be mentioned are marls, stocks, and place bricks. All these are formed in moulds of the same size, and differ only in quality, which depends upon the character of the clay, the care taken in tempering it, and the manner in which it is burnt. The best marls are called firsts, and are used for the heads of doors and windows; the seconds are used for facing, that is, for the front of a building; and for this purpose they are admirably adapted, not only on account of their color, which is a yellowish white, but also for their compactness, and capability of resisting the action of the atmosphere. Grey stocks are sometimes used instead of marls, but they are of inferior quality. Place bricks are the refuse of a burning, and are in fact these which have not been perfectly burnt. Clinkers are overburnt bricks.

For paving, Dutch clinkers, so called because imported from Holland, are frequently used; they are very hard, and have a light yellow color. These bricks are six inches long, three inches broad, and are laid herring-bone way.

Tiles.

There are several sorts of tiles. Paving-tites, used for kitchens and dairies in farmhouses, are about nine inches long, four and a half broad, and one and a half thick. Roofing-tiles are formed in different ways, and are known as pan-tiles, plain-tiles, hip-tiles, and ridge-tiles.

Pan, or Flemish-tiles, are fourteen inches and a half long, and ten and a half broad. It is seldom that these tiles are used, even in country towns, for any other purpose than that of covering sheds and out-houses; and, as they have no pin-holes, they are altogether unfit for a high-pitched roof.

The size of plain-tiles is regulated by law, and they should be ten inches and a half long, six and a quarter broad, and five eighths of an inch thick. They are hung on the laths by oak pins, there being two holes in each tile.

Ridge and hip-tiles are of a semi-cylindrical form, and are thirteen inches long, and sixteen inches girt on the exterior surface.

Brick-making.

Brick should be made of an earthy loam; but the manufacturer is not generally very careful as to the earth he uses, so that it be only possible to make an article which he can sell, or employ himself. Hence it is that some bricks are very brittle, because there is too large a quantity of sand; and others are shaky, because they contain too little, and crack in the drying. It is absolutely necessary for the manufacture of a good brick, that the earth of which it is to be formed, should be exposed to the air, and especially to the frosts of winter, at least during one year, that it may be pulverized, as this will aid the tempering; and the more it is turned over, during the time of its exposure, the better will be the brick.

An experiment, made by M. Gallon, fully proves the necessity of well tempering the earth to be employed in brick-making, "He took a certain quantity of the earth prepared for the making of bricks, he let it remain for seven hours, then caused it to be moistened and beaten during the space of thirty minutes; the next morning the same operation was repeated, and the earth was beaten for thirty minutes; in the afternoon it was beaten for fifteen minutes." After moulding a brick, made of this earth, he found that it weighed five pounds eleven ounces, but one made of the same earth without the same preparation, weighed five pounds seven ounces. When the bricks were dried and burnt, he tested their strength, and found that under the same circumstances, the brick made of well-tempered clay broke with a weight of one hundred and thirty pounds, while the other broke with a weight of seventy pounds. This result clearly proves the necessity of well-tempering the brick earth, which is usually done by a mill, put into motion by horses.

When the clay is prepared, it is pressed into a mould ten inches in length, and five in breadth; but the brick itself, when burnt, is not more than nine inches long, and five and a half broad, on account of the contraction it suffers by exposure to heat, driving off the water which is in combination with the clay. When the bricks are turned

from the mould, which is readily done, the mould being strewed with sand to prevent the adhesion of the clay, they are placed in hacks in a diagonal position, so as to admit the air. Each hack is two bricks wide, and eight bricks, on edge, high. To prevent the access of rain, long sheds are sometimes erected, and the hacks are formed under them; but at other times they are covered with wheat or rye straw. The time required to dry the bricks must depend upon the weather; if favorable, it may be done in six or eight days.

Bricks are burnt either in clamps or kilns; the former are generally used, but the latter are preferable.

Clamps are made with the bricks to be burnt. The foundation is made with place bricks, and of an oblong form. The flue is first formed, passing through the clamp, and about a brick wide. Between each course of brick, a layer of cinders or breeze is placed, the bricks being placed diagonally about an inch apart on each side of the flue. When the clamp is about six feet high, a second flue is made similar to the other, that is to say, if the bricks are immediately required, if not, the flues may be placed about nine feet apart; each flue being filled with coal, breeze, and wood, closely pressed. A layer of breeze is always laid at the top of the whole. The fireplaces are usually placed on the western side of the clamp. The bricks may, if required, be burnt in twenty or thirty days, the time varying according to external circumstances. The outside of the clamp is sometimes plastered with clay when the weather is precarious.

Kilns are frequently used for burning bricks, but more commonly in the country than in the neighborhood of London.—They are to be preferred to clamps, as they require less fuel, and less time is required in the process. The walls of a kiln incline inwards, and are usually a brick and a half thick. A kiln is about thirteen feet long, ten feet wide, and twelve feet high, and will burn about twenty thousand bricks at the same time. The bricks are laid upon an open floor, and after they have been thoroughly dried by a gentle fire, a pile of brick, closed with wet earth, is placed before the fireplace, space being left to add faggots as may be required. When the arches have a white heat, and fire appears at the top the heat is slackened, and then increased, until the bricks are thoroughly burnt, which is generally in about two days. The workman can always determine whether the bricks are dried or not, by the color of the smoke, which turns from a darkish to a transparent color, as soon as this has been accomplished; the burning is then commenced.

The advantages which result from a division of labor are well known, and they are not more evident in any mechanical employment, than in the manufacture of bricks. In a long day, that is to say, between five in the morning and eight at night, a good moulder, will produce five thousand bricks.

There is a very judicious remark in Mr. Partington's Builder's Complete Guide, but we are at a loss to say whether we are indebted to him, or to Mr. Malcolm for it; we have quoted it as it stands in the work we have named. "The color of London bricks is not red, as is the case with the common bricks and tiles, but of a light brownish yellow. This color is more pleasing to the eye, than that of the common red brick, and on this account the London bricks are preferred for building houses. The brick-masters assign a curious reason for this color. According to them, their bricks are kept as much as possible from the contact of the air during the burning. The consequence of this is, that the iron contained in them is not oxidized to so great a degree as in common bricks; but this mode of reasoning is far from exact. If air were entirely excluded, the bricks would not be burnt at all; because the fire would be extinguished. But if enough air be admitted to burn the coal, mixed with the clay, (which must be the case,) that air must also act upon the iron, and reduce it to the state of a peroxide; indeed there can be no doubt, but, that the iron in the London yellow bricks is in the state of a peroxide, as well as in the red bricks; for the peroxide of iron gives various colors to bodies according to circumstances. With it, we find bodies tinged, red, yellow, and brown, according to the substances with which the oxide is combined. We ascribe the color of the London bricks to the ashes of the coals, which, by uniting with the peroxides of iron, form a kind of yellow ochre."

A patent was sometime since taken out by Mr. Shaw for the manufacture of bricks. This gentleman proposed a very ingenious arrangement, by which the clay could not only be pressed into the mould, without manual labor, but be also removed by machinery. The machinery may be moved by any mechanical power, whether it be manual, steam, or horse.

CEMENTS.

Having explained the manner in which bricks are made, and the means of distinguishing their qualities, it will be necessary to state the composition of the several kinds of cement, that are used in order to bind or connect the several parts together; and it may here be necessary to mention, that we shall not confine our remarks to those cements which may be used by the bricklayer, but shall also refer to those which may be commonly employed by the mason; for as we must speak of the origin of the cementitious principle, it seems desirable to explain all the several kinds of substances, in the composition of which this principle is called into action. But before we speak of the cements themselves, it will be necessary to refer to the nature of that substance, lime, which is their principal ingredient.

Lime.

Lime is easily distinguished from other substances by its properties. It is an earth having a white color, and produces a caustic sensation upon the tongue; is incapable of fusion by ordinary temperatures, being one of the most infusible substances in nature, and is but little soluble in water, though it is more soluble in cold than in hot water. Lime is seldom, if ever, found pure in nature, but is generally in combination with an acid; most frequently with carbonic acid, as in the formation of chalk, limestone, and marble. Lime is a very abundant ingredient in the composition of the earth's crust, and generally makes its appearance as a carbonate, but both sulphates and carbonates of lime are found to occur as constituent parts of mineral substances. To obtain pure lime, that is, lime separated from an acid, with which it is uniformly combined in nature, the mineral must be submitted to a red heat, which drives off the acid, and leaves the lime in a state of purity; it is then called caustic or quicklime. Chalk, limestone, marble, oyster-shells, and other substances, are carbonates of lime; and either of these will, when burnt, furnish the material required in building; but the two former are chiefly used for this purpose.

Builders are well aware of the fact, that all limestones or mineral substances containing lime, as an ingredient, do not possess the same cementitious properties.—One stone may yield, when burnt, a lime very superior to another, and this difference depends upon the quantity and character of the advantitious substances, which are combined with the lime. Many of these may be detected by the appearance of the mineral, or by very simple experiments.—When the limestone has a deep brown or red color, it generally contains iron, and when burnt has a yellowish hue; when it does not freely effervesce with the application of an acid, and is sufficiently hard to scratch glass, it contains silex; when it effervesces slowly, and gives a milky appearance to the acid, it contains magnesia. The effects of these and other substances upon cements, have not been accurately determined.

From the London Mechanic's Magazine.

MANIFOLD WRITERS.

Sir,—In answer to the inquiry of "Litera," in your 690th Number, I beg to suggest the following method of procuring several copies of a letter with expedition and secrecy:—

First write the letter with a pen on a sheet of paper, (even as I am now doing,) but instead of ink, employ the greasy or soapy substance well known to those who dabble in lithography, wetted with water, and which looks like a stick of Indian ink folded up in a thin sheet of lead. Then lay the letter fresh written on the face of a lithographic stone, and submit it to high-pressure for a short time; and the characters will be vividly transferred. (If the letter were held for a moment over steam to damp it, the better success of the transfer would be promoted.) Lastly, wet the stone, and print forthwith. All this might be accomplished by one person "*in secret*," in as little time as it has taken me to write this letter. Yours, obediently,

F. O. H. Sidmouthensis.

London, Nov. 1, 1836.

From the Journal of the American Institute.

COAL.

MESSRS. EDITORS,—This community, and, in fact, a large part of the country, are alive to the high price of coal. Winter is gathering upon them with increasing sternness; and although thus far not as frightful as the last, the dread that the worst is still to come, agitates and alarms. This condition of the public mind is calculated to bring forth advisers in scores; because it is a time when they will be listened to. Some favorite panacea becomes popular. The people, like suffering patients, are sure that they feel distress, and, like them, they cannot be satisfied until they have swallowed the popular remedy, or been bled or steamed, as the fashion at the time may dictate.

The sovereign specific—the grand catholicon—which will make plenty, and, of course cheapness, is free trade;—take off all duties, and open your ports to the whole world, and all will be well. Petitions to Congress for this purpose have been circulated, and thousands have signed in the full belief that they were contributing thereby to mitigate the rigors of our severe winters, and bring our shivering inhabitants into a milder zone. I have been repeatedly accosted by those engaged in carrying around these petitions, to lend my name—to inform Congress that the weather is cold, and that fuel is high, and humbly pray them to pass laws to make us warm:—not exactly to legislate us into a milder climate, but to legislate down the price of coal, by taking off the duty, about $2 per chaldron, which is required to be paid on imported coal. Not having a particle of confidence in this prescription, I have sought for reasons from those who take such interest as to go from house to house and store to store, to beg signatures.

I have desired them to name an instance, when the means of a home supply existed, where a reduction of duties effected a reduction of prices. I desired them to examine the history of our tariff, and see for themselves whether reduced prices had not been the invariable effect of high protecting duties. I instanced to them cottons, leather, cabinet wares, hats, &c., which were among the earliest articles protected by high duties, and which duties have been regularly contime tinued down o this; all these are now so abundant and cheap, that we are deriving a good profit while we undersell them in foreign markets to those very foreigners from whom formerly, before high duties were imposed, we purchased our supplies. Not a free trade coal advocate has been found to deny these facts.

I have not, however, been so fortunate as to shake the faith of a single man. It is opposed to their theory; they are suffering, and, like the afflicted patients, unwilling to submit to a gradual, but certain cure, they yield to the persuasions of the empiric, and shut their eyes against facts and experience. Some have said that coal is an exception; that all that is wanted is to break down the coal monopolizers, extortioners and grinders; that coal is necessary for the poor. I ask, is not bread, too, a necessary? Do not flour dealers monopolize? It has been stated, that there is a confederacy of monopolists extending from New-York to Buffalo; and it is probably truly stated, that a more universal scarcity in bread stuffs exist from the short crops of the last season, than has prevailed at any time within the last fifteen years.

The duty on foreign wheat is twenty-five cents per bushel. Are there not stronger reasons for the repeal of this duty, than even the duty on coal? Are the flour monopolists less obdurate? Is their combination more limited, or less effective? Is the future supply less certain? Let those who doubt explore the coal regions of the west, and they will find a supply, not thousands of feet below the surface, as in England, but forming the very surface itself, and of sufficient depth for the supply of not only America, but all Europe, for centuries to come. That the susply is inexhaustible, no one will deny. From the best calculations, it may, under ordinary circumstances, be afforded in our city at less than half its present price.

The supply of wheat cannot be relied on with the same certainty. Bad crops may occur, and reduce production particular years greatly below the common average, as they did the last year. No deficiency can happen in our coal beds. Why then these extortionate prices? Coal has suddenly superseded other fuel, not only in our populous cities, but in the country—for manufactures, for steamboats, as well as to warm our houses. Just as our forests had disappeared, our coal beds—those exhaustless magazines of fuel—began to be known.

It is but a short period since a few samples were brought here for exhibition. The last

year there was brought to market, from three mines in a single State, 556,935 tons; and for the coming year, preparation for its supply are making upon a larger scale than ever. The ratio of increase from these mines alone, is such as must soon fully equal the demand, and new mines are constantly opening; and the competition, so highly stimulated by ready sales and high prices, must inevitably and speedily reduce the article to its minimum price, unless that competition is checked by indiscreet legislation. All that is required, is for more capital to be turned into the coal trade at home

If the facilities for the importation of foreign coal are increased by the repeal of the duty, the inducement for our capitalists to make extensive arrangements for supplying our market the next year is clearly lessened —probably to a tenfold greater amount than the increased foreign importation. The foreign importation is also calculated to derange prices. This consideration, in all probability, would influence the capitalist to withhold the employment of his money beyond what it ought to be invested.

The foreign supply, under any circumstances, will be but a drop in the bucket, when compared with our consumption. The foreign importations of last year were only 14,453 tons. If that amount were imported for forty years in succession, it would but a trifle exceed the amount procured the last year from the three mines I have already referred to. If the repeal of the duty were to be doubled, the foreign supply would amount only to a fraction, compared with the probable home supply of the coming year.

I defy those who desire the repeal of the duty on coal, to name a reason which does not, in full force, apply to wheat, and flour, and potatoes. The present prices of these latter articles, beyond the average of former prices, is quite equal to those of coal. The duty, in proportion to present prices, is as great; and the possibility of a real scarcity, from short crops, may happen to wheat, flour and potatoes, but never can to coal.

The quantity of coal brought to market for several years past, has doubled every three years. Our population requires about twenty years to double. The article is, therefore, increasing more than six times as fast as the consumers. Under these circumstances, we have nothing to do but to give competitien full play, and monopoly soon will get its quietus.

Suppose we admit, because coal is a necessary, and the price is high, that the duty ought to be repealed. The same reason will apply to every other necessary. We must carry the principle through, or stand charged with partiality; and in years of plenty, our markets would be glutted with the agricultural products of Europe, and our farmers made the sufferers. Motions and petitions would be offered in Congress to repeal the duties on other articles, and our whole social system would be disturbed and deranged. Pennsylvania would not be peaceable if, without a good reason, her great staple should be made an exception. Our whole protective policy must be demolished. To me it is folly to *endeavor* by a repeal of duties, to tempt our citizens to send their money three thousand miles, and employ foreigners to dig coal from the deep bowels of old England, instead of using it at home in rewarding our own industry, and by its circulation enriching our own people. It would be much sounder political economy to give bounties to encourage its exportation, and by these means break down the monopoly so loudly complained of. CLINTON.

That the price of coal will be regulated by supply and demand, will not be denied. The question then arises, will the supply be increased or diminished, by the repeal of the duty on foreign coal? We believe it will be diminished. With the coal dealers, who fully understand the subject, it will have no effect; but some sensitive capitalists will, no doubt, be influenced to withold their money, which they might otherwise employ in the coal business themselves, or loan to others disposed to carry it on. The whole quantity that, under any circumstances, will, be imported, must be so small, that comparatively a very little effect on our coal operations will more than overbalance the increase from importation, arising from a repeal of the duty. The consequence will be, that coal will bear a higher price than if the duty is continued. And we are told, that some of the most intelligent coal dealers are perfectly willing for the repeal, and laugh at those who think by such means to affect their trade. In 1820, only 365 tons were brought to market from all the Pennsylvania mines. In 1835, 556,935 tons. Fifteen years, therefore, had increased the quantity fifteen hundred and twenty-five times. No monopoly, if the business is let alone, can long withstand the accumulating supply.

Our correspondent has overlooked a very important consideration which has helped to sustain coal the present season. The severity of the last winter caused an extra consumption, which has been computed at fifty per cent. Great numbers, to guard against extortionate prices, obtained their winter's supply the last fall, contrary to their practice in former years. There is not, therefore, exhibited in the coal yards the quantity which, it would seem, might be required. Instead of being there as formerly, and in greater abundance, it is in the vaults of individuals. We believe at this moment the aggregate of coal in the yards and private vaults, will exceed the winter's consumption—especially if the winter continues as favorable as it has commenced.

Some have been alarmed because the coal mines have been alleged to be in a few hands, who have it in their power to perpetuate a monopoly. A very little knowledge of our country would satisfy them that a company might as well monopolize the land as the coal. As our correspondent says, new mines are constantly making their appearance; and the positive indications of others are abundantly sufficient to quiet all apprehensions from monopoly. In no one thing has Providence been more bountiful to the United States, than in the article of coal. We may as well alarm ourselves at combinations to monopolize water or air. If our members of Congress, who are so distressed about the poor, will substitute for their repeal bill a bill for the appropriation of a sum equal to what the debate will cost, if it is entered upon—for the purpose of getting coal, to be sold to the poor at a fair price, they will manifest more sense, without diminishing at all the claims for our confidence in their sincerity.

The idea of those who would repeal the coal duty, to help relieve us from the admitted evils of our surplus revenue, will pardon us if we find their proposed remedy bordering on the ludicrous, inasmuch as the revenue from that source has not, in years past, averaged forty thousand dollars per annum?

If a proposition should be made to empty one of our lakes with ladels, it would not be more ridiculous. The time expended by Congress in hearing a dozen long-winded speeches, calculating the ordinary per diem cost, will operate much more effectually in this reduction, and would indeed afford the only argument we have ever heard in favor of the everlasting speeches, fashionable in the national school of rhetoric at Washington.

We will sum up what we have to say. Let the consumers of coal, eschew all petitions, keep up their courage, and be of good cheer, exercise rigid economy in the use of coal this winter, and we have no doubt but that the coming spring, the monopolists of coal will be sufficiently punished by a surplus that must remain a burthen to them until another season. The report on the Morris Canal, published in a former number, a document made up with great care, affords us the cheering information that by means of their canal, anthracite coal may be afforded for \$3 66 per ton, and bituminous coal at \$4 56—delivered in the city of New-York. As sure as cause and effect follow each other, the price must be soon reduced so as to afford to those engaged in it no more than a bare reasonable profit.

About a year since an article was published in this Journal on the subject of the employment of zinc for roofs, by Dr. L. D. Gale, and in this article it may be remembered that several serious objections were urged against the employment of that material. The following article from the American Journal of Science and Arts—January 1837, will be found to give an entirely different view of the subject.

It is highly important that the merits of the case should be well ascertained before opinion is made up. Believing that the experiment detailed by Dr. Gale could not give erroneous results, we had decided in our own minds. It appears however, that further experiment is necessary.

ON ZINC, AS A COVERING FOR BUILDINGS; IN A LETTER FROM PROF. A. CASWELL, TO MESSRS. CROCKER, BROTHERS & CO.

You sometime ago requested me to examine an article on *Zinc, as a roofing material*, published by Dr. Gale of New-York, in a late number of the Mechanics' Magazine. I regret that it has not been in my power to give your request earlier attention.

The remarks of Dr. G., which were co-

pied by several papers at the time, were fitted, in your opinion, to prejudice the public mind unjustly upon a subject of great importance. He discourages the use of zinc as a roofing material, upon several distinct accounts, the principal of which, are the following.

1. The difficulty of making the roof tight.
2. The deterioration of the water which falls from it.
3. The comparatively small resistance which it offers to the progress of fire.

1. As to the first of these objections, the brittleness of the metal and its great expansion from heat are adduced, to show that a roof cannot be made sufficiently tight.— Zinc in the *unwrought* state is well known to be very brittle, and there may be in the market *rolled* or *sheet* zinc of a bad quality. But no one need be deceived on this point, since nothing is easier than to test its flexibility. Sheet zinc which will bear to be doubled and hammered down without any appearance of fracture in the bend, may be used as a covering for buildings, without the least fear of leakaga. Such is ths fact with regard to sheet zinc which I have examined from your manufactory; and such, I am assured, is the fact with regard to foreign zinc from the best manufactories. But any detailed examination of the brittleness and expansion of zinc, so far as this question is concerned, is entirely obviated by the well ascertained fact, that there is no practical difficulty in making a zinc roof *perfectly tight*. The numerous certificates which you have submitted to my examination, from most respectable gentlemen, who have made the experiment, place the subject beyond all reasonable doubt. A zinc roof may as easily be made tight as any other whatever.

2. The second objection respects the deterioration of the water which falls from the roof. This consideration is particularly important to all those who are in the habit of using cistern water for culinary and other domestic purposes.

It is alleged that a *poisonous* suboxide of zinc is dissolved in the water, which renders it unfit for *cooking*, and impairs its proprieties for *washing*. On this point I have consulted the ablest modern writers on chemistry, Brande, Turner, Thomson, Berzelius, and others. The oxides of zinc seem not to have been much studied. The principal one known, and perhaps the only one certainly known, is the white oxide, (sometimes called the flowers of zinc,) which is quite ***insoluble*** in water, and hence could not vitiate its proprieties. Berzelius thinks there are two others, the suboxide and the superoxide.

The ***suboxide*** is the gray coating formed on the surface of zinc by exposure to the weather, and this is the substance which, it is said, is dissolved and mixed with the water, which falls from a zinc roof, thereby impregnating it with deleterious properties. This opiuion, so far as I can learn, is unsupported by any writer on chemistry. Turner says, "zinc undergoes little change by the action of air and moisture." Aikin's Chemical Dictionary, a work of merit and authority, says, "the action of the air upon zinc, at the common temperature, is very slight; it acquires a very thin superficial coating of gray oxide, which adheres to the metal and *prevents any further change.*" The statement of Thomson is, that zinc, when exposed to the air, soon loses its lustre, but "*scarcely undergoes any other change.*"— The account given by Berzelius, the ablest chemist of the age, is very explicit and much to the point. He says, "this oxide is formed on the surface of zinc which remains a long time exposed to the contact of the air. It has a dark gray color when moistened, but by drying becomes of a light gray. Ordinarily it forms a thin crust on the surface, which neither ***increases*** nor ***experiences any change in the air;*** but acquires great hardness, and resists, better than the metal itself, the mechanical and chemical action of other bodies. A piece of zinc sufficiently suboxidized at the surface, dissolves with ***extreme slowness in the acids, and only at the boiling temperature.***

Such are the opinions of chemists, and particularly of Berzelius, whose unrivalled skill and accuracy in chemical analysis have been the admiration of all cotemporary chemists.

The opinion of Dr. G., is considerably at variance with those now adduced. I think he has not stated very fully, and certainly not very satisfactorily, the reasons on which it is founded. He mentions, however, as a proof that this suboxide is dissolved in water from zinc roofs, that if it is suffered to stand for some time exposed to the air, the suboxide gradually takes oxygen from the atmosphere, and is thus converted into the ***insoluble*** white oxide before mentioned, and is then

precipitated in the form of a white powder. To test its purity by this method, I have kept water from a zinc roof exposed in clean glass vessels for several days, without any, the slightest appearance of a precipitate, or even a pellicle upon the surface. And what is still better as a test, I have kept it for several days in closed bottles with oxygen gas, and subjected it tŏ frequent agitation, without the least appearance of a precipitate, or any diminution of transparency. I must think, therefore, that if such water contains the suboxide of zinc, its presence is not to be detected in this way.

That the quantity of zine dissolved in water *must be exceedingly small*, is obvious from the following consideration. A sheet not more than the fortieth of an inch in thickness, would probably last at least half a century, on the roof of a building. Indeed, for any thing we know as to the *rate* of its oxidation, it might last for centuries. The concurrent opinion of chemists, and this confirmed by obsarvation and experimeut, so far as these have extended, is, that after the gray oxide is once formed, any further change takes place *scarcely at all*, or with *extreme slowness*. But on the supposition that it would last only fifty years, the whole quantity of rain which falls in the course of a year, or about three feet on the level, would dissolve the *two thousandth part* of an inch in thichness of zinc. This, to produce any appreciable effect, must be one of the most virulent of poisons, equal at least to prussic acid. But so far from being an active poison, it remains to be shown that it is poisonous at all, even if a minute portion of it did mingle with the water. The white oxide of zinc is not poisonous, and the inference seems to be gratuitous that this is so.

It is due no less to the public than yourselves, that the truth upon this subject should be known and promulgated. I am quite satisfied, for one, that we are not in the least danger of being poisoned by the use of water from zinc roofs. The portions of this water which I have examined, could not be distinguished from pure river water by any test that I have been able to apply to it. I feel myself warranted, therefore, in the conclusion, that *it has suffered no deterioration whatever from the zinc.*

3. A third objection is that zinc affords inadequate protection against fire.

This objection is based upon the fact that zinc melts at a low temperature; and in case of fusion, leaves the wood work of the building unprotected. This objection is rather specious than real. Zinc melts at the temperature of about 700° Fahr. or a little below red heat. Whenever, therefore, the heat from adjacent buildings is any thing less than that of redness, zinc would afford as complete protection as copper or iron.—When the heat has reached the melting point of zinc, which it seldom would do except in the most compact parts of cities, very little confidence could be placed in the protection of iron or copper. The dry wood work of the roof, under a covering of red hot iron, with air enough for combustion circulating through openings and crevices, would soon be in flames; and when once in flames it would be extremely difficult to extinguish it by the application of water. It would be applied with great disadvantage to the under side of the roof, and almost to no purpose at all upon the top. If therefore the heat, in any case, should become so intense as to melt zinc the probability of protection from iron or copper will be but small.

Complete protection against fire is perhaps unattainable; at least we can never be sure we have attained it. In the progress of the arts, great improvements no doubt will be made in the mode of defence against the attacks of this destroyer. I am not aware that the following construction for a roof has ever been tried. For cheapness, tightness, durability and resistance to fire, it seems to be well deserving the attention of builders. Let the rough boards of the roof, (and the rougher the better,) be covered with a thick coating of common lime mortar, then lay down the *ribs*, if I may so call them, for the zinc plates,—then cover the whole with zinc, according to the most approved method of applying it. Such a roof would be in no danger of leakage, unless the water accumulated upon it so as to stand above the ribs, in which case no roof would be tight unless it were corked or soldered throughout. This covering, if I am rightly informed, would be nearly as cheap as slate—quite as cheap as tin, cheaper than iron, and more than three times cheaper than copper; and would at the same time resist fire much better than either of them. A heat that would melt down the copper and iron, would of course, melt the zinc, but would leave the mortar uninjured. The peculiar advantage

of the mortar is, that it is infusible except at a very high temperature, while the closeness with which it adheres to the wood work is such as to exclude the air and thus prevent combustion. If the mortar should be kept at a red heat for some length of time, the wood beneath it would be *charred*, but could hardly be *burnt*. In case of fusion the zinc might be replaced without injury to the mortar. I know of no construction for a roof that would be more completely fire proof than this.

Such are my views on the subject to which you called my attention. If they shall serve in any measure, to remove prejudice, and allay unfounded apprehensions on a subject of great and growing importance to the public, it will afford me much pleasure.

Brown University, October 1, 1836.

From the Journal of the American Institute we take the following article on an interesting subject.

The following extracts from a correspondence between Mr. Durant, of Jersey City, and a well known friend of domestic industry, has been obligingly furnished us for publication. We think it will particularly interest our silk-growing readers.

New-York, Nov. 28, 1836.

Sir,—You will recollect suggesting to me last summer, that you was engaged in experiments to produce two or more crops of silk worms in one season. If this could be effected, it is evident the quantity of silk might be greatly augmented in our country. It is not necessary to dwell on the importance of experiments for this purpose, when we know that fifteen or twenty millions of dollars of our hard earnings are every year drained off into foreign countries, for silks which we consume. Fifty thousand bushels of wheat, say one hundred thousand dollars value, is sufficient to put our "*let alone*," or "*free trade*" advocates almost into convulsions, while their nerves are as calm as "a summer's sea" under a full knowledge that more than one hundred and fifty thousand times that amount in silk was imported last year.—But not to dwell on the absurdities of this misnomer, free trade, (which I trust our farmers, who are intended to be entrapped, will perfectly understand,) I will proceed directly to my object, which is to ask from you a detailed statement of your experiments the last season, in producing two or more crops of the silk worm.

Experiments for a similar purpose are making in France. The eggs have been kept from hatching in ice houses, until the time when the hatching process is to be commenced. Experiments made by keeping the eggs in a cellar, where the variation of temperature was from six to nine and a half degrees, were unsuccessful, being, as expressed, too great to keep the living principle dormant.

I am one who fully believe that we are, in a few years, to go ahead of all other countries in producing this commodity—a commodity which must be invaluable, in helping to a favorable balance in trade, as, like specie, it will exchange in any market in the world. Let the ingenuity and tact of our country be brought to bear on its production, and there can be no mistake. But our silk culturists should have early and accurate details of all important experiments made by each other.

Yours, respectfully.

Mr. Charles F. Durant.

Jersey City, Nov. 30, 1836.

Sir,—Your letter, soliciting a detailed statement of my experiments the past season to produce two or more crops of the silk worm, is before me.

I agree with you in the opinion therein expressed, that "the silk culturists should have early and accurate informatian of all important experiments made by each other," though I doubt whether much benefit is derived from a publication of the crude essays and mere approximation to some desirable result in physical science. Such is the state of the experiments to which you allude; with the object only partially accomplished, I have sanguine hopes of ultimate success: and yet I fear it would tire your own and readers' patience, to hear a recital of all the reasons that support these hopes, or the causes which have operated to prevent the success of the entire series of experiments

The desired object, as I remarked to you, was a succession of worms, from the first opening of the leaf in spring until it can no longer afford that nourishing matter so essential to the life and production of the

worm. This, in the latitude of 40°, would embrace a period of about five months, say from May to October, and would permit nearly four successive crops to occupy the same shelves, allowing forty two days for the feeding or first state of existence, which, I think, will be the average duration, with the temperature of this latitude.

Seven successive crops, in this period of time, may occupy the same shelves, if for the first twenty days in the existence of each, they could be fed on a shelf specially appropriated for that purpose. This, I think, should always be done; for, at this age, they do not occupy one hundredth part of the space which they require when winding, and consequently, there must result by this mode, a great saving of room and labor to feed them.

By this method, I fed two crops on one frame the present season. They were both from eggs of 1835. The eggs of the first crop were kept uncovered the entire season, where they were deposited by the moth, at my residence in this place, exposed to York Bay and the sea air—the sash of one window lowered three inches, to admit at all times the temperature of the season; and, notwithstanding the extreme cold of last winter, every fecundated egg was hatched from the 7th to the 9th of May, before trees in the open ground had put forth leaves.

I had anticipated this result, and in autumn covered with sea-weed and bass matting a nursery of young trees in the garden. On these the leaves began to appear as early as the 17th of April, and by the 9th of May furnished abundant food for the crop, until they could be supplied from trees in the open grounds. They completed the first state of existence from the 17th to the 23d of June. The cocoons were large, and, with a few exceptions, perfectly formed. With a mere theoretical knowledge of the process, I reeled them without difficulty; and some sewing silk, which I made from the same stock, was judged by connoisseurs equal to the best imported from Italy. You saw specimens of the whole at the last Fair of the Institute, and I think you will agree with me, that the result of the experiment will warrant the assertion, that *silk worm eggs can be preserved uninjured through our coldest winters, and silk of a good quality produced without artificial heat.*

The second crop was from eggs of the same year as the first, and produced by *retarding* the process of nature. With this view, the whole experiment was planned and commenced as far back as the second state of existence, by enclosing the cocoons in a box, to shut out the light. They were then removed to the cellar, where the temperature was lower than the room in which they passed the first state. This kept the chrysalis back seven days longer than those in the feeding room. As soon as they attained the winged or perfect state, I separated the moths, to prevent copulation, till the end of six days, which is a further gain of four days. Most of the eggs were fecundated, as very few were deposited previous to copulation. The box was kept closed, and removed to the room previously described, which exposed the eggs to the same temperature and treatment as those for the first, except the exclusion of light, and removed to the cellar again in March, to prevent the temperature rising above 55 Fahrenheit. From the 15th of May, I opened the box a few minutes each day, to observe with a microscope the progress of the embryo worms, which had advanced so far on the 21st May, that I feared injury from the humid atmosphere of the cellar, and removed them to the feeding room. On the morning of the 30th, a few worms had escaped from the eggs; and, judging it imprudent to keep them longer in embryo, I placed them on a sheet of paper, exposed to the direct solar rays through the window. Every fecundated egg passed to the first state by the evening of the same day. They were in number about four thousand, apparently healthy and vigorous.

The first crop was now twenty-two days old, and occupying the frame on which they continued to be fed, until the winding of the cocoons, which was accomplished by the 21st of June, when they were removed, to give place to the second crop, which were now twenty-two days old, and so small, that up to this time, the four thousand were fed on two sheets of paper. On the 15th of July, most of the second crop had finished winding. The cocoons were generally small and imperfect, though

a few among them were nearly equal in size and perfection to the first.

The probable cause of this deficiency in size and quality of the cocoons, can be traced to so many parts of the experiment, that a description of all would require more time than I can at present devote. The dampness of the cellar probably contributed largely, as *water*, in all its forms, whether in bulk, dew, or vapor, is a *bane* to the silk worm. In some instances, protracted rains obliged me to pick leaves in a wet state, and, though I dried them between cloths, probably particles of water still adhered to them. During the latter part of their feeding, the hydrometer indicated a humid atmosphere, and it was at times so cold, that Fahrenheit fell below 60°—an injurious effect, which I could not counteract, as I had resolved to dispense with artificial heat. That these were the most immediate causes, I infer from the fact, that a few of the cocoons were large and perfectly formed.

You remark, that "experiments made in France, by keeping the eggs in a cellar where the variation of temperature was from six to nine and a half degrees, were unsuccessful, being, as expressed, 'too high to keep the living principle dormant.'" In the degrees of temperature, I suppose you allude to the centigrade scale, as modern French chemists have wisely adopted the Celsius thermometer, by which pure water, under a barometrical pressure of thirty inches, will freeze at zero and boil at 100°. By this scale 9.5 plus corresponds to 49.2 of Fahrenheit, an average temperature *below* that of my cellar, which proves that the French experiments did not fail from the causes stated by them, but rather by commencing *too late.* To produce a second crop by this process, we must commence as far back as the moth of a previous year.

My experiments for a third, and succeeding crops, were to *hasten the process of uature*, by producing an artificial winter.—For this purpose, I placed the eggs of the first crop, as soon as deposited by the moth, in an ice-house, and, at the end of sixteen days, submitted them to the action of solar heat, without the desired effect.

Some eggs, after remaining six days where deposited by the moth, I submitted to a winter of plus 3° Fanrenheit, by mixing sulphate of soda five parts, and diluted sulphuric acid four parts; others to a temperature of plus 10°, by muriate of ammonia five, nitrate of potash five, and water sixteen parts, and then exposed them to the solar heat. Though these attempts proved abortive, I still think that nature may be supplied with an *artificial winter*, and eggs hatched the same month in which they are deposited by the moth.

When such a desirable result is accomplished, who will fix limits to the immense wealth which the silk worm will create in this country? Silk, from remote times, has been a source of immense wealth to Asia. Its cultivation has kept pace with the intelligence and riches of Europe.—Our country has all the essential advantages of climate for its production, with a numerous and intelligent population, who cannot fail to see the advantages of appropriating to their use the valuable labor and productions of a worm, which can create a greater revolution in political economy, with such simple means as nature ever employs to work good results, than did Gaul's great emperor make in political existence with the sword, fire, and concomitant horrors of a continental war.

Yours, &c.,
C. F. DURANT.

M. Thenard has resigned the Professorship of Chemistry at the Ecole Polytechnique, and it is expected that he will be succeeded by M. Dumas.

The British public will learn with regret that Mr. M'Adam, the benefactor of his species is no more. He was, however, as full of years as he had long been of honor, and expired at Moffat on the 26th, in his 81st year. Mr. M'Adam has left a widow and two or more sons by his first marriage, upon one of whom was conferred the title of knighthood, which his father declined on account of his age and infirmities. In manner and address no man could be more agreeable; in place of being a mere roadmaker, he was a man of science generally, intelligent on every subject. From Government he received, in two different instalments, ten thousand pounds—a very slender reward, indeed, considering the vast utility of the improvement he originated.—[Scotsman.]

INTRODUCTORY LECTURE,

To a course delivered before the General Society of Mechanics' and Tradesmen, by James Renwick, L. L. D., Professor of Natural Experimental Philosophy and Chemistry, in Columbia College, New-York.

In opening the first course of public Lectures which has been prepared for this Institution, I cannot but feel that my task is attended with some difficulty. Unable to forsee the wants and wishes of an audience now for the first time assembled, I have been in doubt whether it would be best to adopt a strictly scientific, or a merely popular plan, or whether a middle course might not be preferable, in which the dry discussions of pure science should be relieved by illustrations of a more familiar character.

There has also, been a question whether the few lectures ought not to be devoted solely to such subjects as might possess the charm of novelty, and thus illustrate no more than the recent additions which have been made to philosophic knowledge, or whether they should embrace matters more familiarly known.

It has, after due deliberation, been inferred that this audience has not been collected merely for the purpose of learning what has recently been done in science, but would prefer to receive a connected view of the subjects which may be treated of; in which way, while mere novelties will not be wholly excluded, they will occupy no more space than their real importance entitles them to demand It often happens that a new discovery attracts for a season an undue portion of attention, and different subjects have thus, in rotation, filled up a measure of the time devoted to the study of science, far beyond that which is due to their intrinsic merits, or their value in practical application. Thus, common electricity for several years demanded nearly half the time which was devoted to the physical sciences; it was then superceded by galvanic electricity; while at the present moment electro-magnetism and the polarity of light, are the fashion. Without pretending to undervalue either of these branches of knowledge, it is sufficient to say that they have not been considered of sufficient practical value to be introduced in the opening course of such an Institution as that at whose request, I have the honor to address you.

In determining, then, to have reference rather to the real importance of the subjects to be treated of, than any temporary interest they may have assumed from novelty or fashion, two distinct modes of proceeding have presented themselves. It might, in the first place, have been attempted to compress, within the prescribed limits of the lectures, a brief and general view of the whole extent of physical science. Such brief and general view might not be without its interest, but it would necessarily have been condensed within a space so confined as to render it extremely difficult to give to such of my hearers, as may not have had the benefit of a previous acquaintance, with at least, a part of the subject, any clear and satisfactory idea of the whole. This plan would also have labored under the disadvantage of excluding in a great measure, all experimental illustration.

In the second place, it is easy to select from the variety of matter included under the general head of physical science, a few subjects of important practical value. Each of these would then admit of being fully investigated, and full space would be allowed for rendering them interesting by experiment and apparatus.

The latter has, for such reasons, been considered the preferable plan, and this view of the subject has received the sanction of the very intelligent committee of the Institution.

In respect to the style, which it would be most expedient to adopt, I have, upon my own responsibility determined on framing

the lectures in a plain and didactic form, rather than attempt to dress them in literary ornaments. For the subsequent evenings of the course, the reading of written lectures will be avoided as far as will be consistent with a clear and perspicuous exhibition of principles. Conceiving that it is probable, that, at least a part of the audience, has had no opportunity heretofore of iustruction in physical science, and is therefore assembled for the purpose of acquiring elementary knowledge, the mode which experience has shown to be best adapted to that particular object will be pursued. To those of my auditors who have already made proficiency in such studies, this must serve as an apology, for bringing before them matters to which they are familiar. Still, even to them, it may not be uninteresting, to review what they have long since acquired; and to fortify their recollections by witnessing again facts and illustrations, which, however often repeated, cannot wholly cease to be worthy of attention.

If such impressions be not erroneous; to define the limits of the sciences which fall within the scope of my studies, and to point out what parts of them have been selected as the subjects of the present course, will form no unfitting introduction.

The physical sciences present a wide and extensive field. More than two centuries have elapsed since the proper mode of studying them was revived, and the few sound principles with which the ancients were acquainted, restored to their proper rank in the scale of human knowledge. From the time of this revival up to the present hour, no year, and indeed hardly a month, a week, or even a day, has elapsed, which has not added to the present stock of facts. From these facts, general principles and laws have been continually deduced, until the science of natural philosophy, which was at first of so little extent as to permit of its being successfully cultivated in connection with others, has been necessarily divided into many distinct branches, each of which may well occupy the whole attention, even of the most powerful intellect.

Physical Science, or, in other words, Natural Philosophy, has for its object, the laws which govern the phenomena and appearances of the material world. Every thing, therefore, which is capable of perception by our senses, falls within its province, as well as all the agents which are efficient in influencing them, whether these agents be themselves objects of sensation, or known, only by the effects they produce on the bodies which are.

The world with which we become acquainted by the evidence of our senses, and to which the name of material has been given, is made up of many substances extremely diverse in their specific characters, and yet agreeing in a few general properties, which enable us to class them all under one general term. This term is Matter.

In what the essence of matter may consist, we know not; nor is it probable that we shall ever learn, in this limited state of existence, the final causes by which it is separated, on the one hand from mere space, and on the other from spiritual existence. Metaphysicians have indeed with subtle ingenuity speculated upon these causes, until they have resolved matter into collections of mere occult qualities: while others have refined until they have denied its existence altogether. Such refinement of ingenuity appears almost ludicrous to the uninstructed mind, and it is not less repugnant to those who study physical science in the true spirit of philosophic inquiry. To those imbued with this spirit, or such as enter upon the study unbiassed, it is unnecessary to refute such sophistry. The error lies at the root of the inquiry; and it may be safely asserted, that, wherever metaphysical arguments are admitted into the discussions of natural philosophy, the chance of discovering truth will be in a great measure lost. It is from our senses, either unassisted, or aided by the in-

struments which the advance of science has both called for and supplied, that the whole basis of natural knowledge is to be derived, and it is to our senses that we must finally appeal to determine whether the inferences built upon that basis are correct or not.

In making the testimony of our senses the basis of all our knowledge of physical science, we proceed in one of two ways, namely: by observation, or experiment.

We are said to observe, when we watch for the phenomena as they occur in the regular course of events, and merely note the appearances which these phenomena present. We are said to experiment, when by means of apparatus or preparations, we cause actions to begin, which would not have occurred in the spontaneous order of nature; in this method of proceeding, we may not only induce an action, which might not have taken place without our intervention, but we may modify, and in some cases, cause it to cease; but we can do no more. The phenomenon itself is due to natural causes which are beyond our control, and escape our scrutiny. Hence experiment, after all, is no more than a case of the more general method of observation, the proper time for which, we may choose for ourselves, but whose result is independent of us.

These two methods cannot be adopted indiscrminately, nor is each applicable in every different instance. Thus, if we wish to examine the phenomona of the heavenly bodies, no other method is practicable but that of observation; their motions proceed in a space far beyond the limit of any of our senses except that of sight, and the several appearances which they present, occur at regular periods, but in a way which is beyond any control or modification on our part. Astronomy is therefore emphatically the science of observation. But when we wish to examine the internal constitution of bodies, we find the elements of which they are composed, united by forces which require the application of a more intense force of the same description, or of some powerful physical agent to overcome them. Such forces we can call to our aid, and such physical agents we can control and employ. Chemistry is therefore as emphatically the Science of Experiment. Other departments of Natural Philosophy may be investigated by mixed methods, in which observation and experiment, each fulfil their proper office.

It may perhaps be urged that the evidence of our senses is far from being infallible, and there is probably no person persent who may not, at some time or other, have been led into error, by relying upon this evidence alone. We have however the means of comparing and combining a number of different appearances, and of reasoning upon the basis of other phenomena, in relation to which no doubt can possibly exist, and we may in this way correct what would at first give rise to erroneous impressions, and actually deduce and demonstrate the true state of things, from the very perceptions which at first appear to contradict it. Thus, a savage or a child, who for the first time contemplates his own image in a mirror, may think this image the actual body of another person. By bringing the sense of feeling to the aid of that of sight, he will speedily learn the existence of the mirror, in what at first appeared an empty space, and careful observation will prove that the position of the image is dependent upon that of his own body, and follows his own motions; but if the appearance were to occur for the first time to one acquainted with the general laws of the reflection of light, he would be at once enabled to include the phenomenon of the image among the cases of that general problem. So also, our senses appear to inform us that the sun rises daily in the East, and performs his appointed course until he sets in the West, over the firm and apparently immoveable earth. So soon as his light has faded, innumerable stars show themselves which seem to be affected by a similar motion. But he who has made progress

in physical science, can, by the very comparison of these apparent motions with each other, prove that they are all owing to the rotation of the planet of which we are ourselves inhabitants; which, so far from being of the importance that a comparison with our own pigmy stature leads us to beleive it, is a mere point in the vast system of the universe, and instead of being at rest is in a state of continual and rapid motion. The sun himself can be shown to be a million times and more, as large as our puny earth, and many of the stars, which to us seem mere luminous specks, to be even greater than that splendid luminary. Yet the whole of this knowledge rests for its basis upon the very facts, which to our first impressions, seem to demonstrate the reverse of the truths which are finally attained.

In order to understand how truth may be reached, even from contradictory appearances, it is expedient that we should treat in a brief manner of the mode of proceeding in physical science. This method is founded in nature, and is not only that by which philosophers proceed, when they pursue a proper mode of inquiry, but is that, by which children and the rudest individuals of our race, learn whatever is absolutely necessary to their safety and sustenance. As we advance in age, and in mental cultivation we are often tempted so deviate from the path which nature has pointed out, in the pursuit of more easy roads to truth; prompted partly by indolence, which induces us to endeavor to avoid the slow and laborious method, by which alone, true knowledge can be acquired, and partly by the influence of bad example. It therefore becomes necessary that rules for conducting the process should be laid down, and that we shall never be satisfied that our inferences are correct unless these rules have been rigidly adhered to.

The basis of all physical knowledge has been stated to lie in experiment, and the careful observation of facts. The truths thus obtained, so long as they are considered individually, are of value to direct our practice, only when the circumstances under which they were originally noted, recur without variation. It is not only necessary to record them, therefore, but to classify them; in order that phenomena, which are probably connected, either in their supposed cause, or in their appearances, may be considered together. Up to this time we use no scientific process, the record and classification of the facts, is purely historical, and has been said to constitute a department of that division of human knowledge, under the name of Natural History. This name, it may be incidentally stated, is now usually given to the description of the external characters of the bodies which we rank by their obvious qualities in the three great kingdoms of nature, the Mineral, the Vegetable, and the Animal. This department of knowledge has, however, been elevated, by the introduction of Philosophic reasoning, to the rank of a science, and we should, in speaking of it, give it its true value, by including its several branches under the denomination of "The Natural," as distinguished from the Physical Sciences.—When certain facts, obtained by observation or experiment have been classified, we are generally able to find among the phenomena which they present, one or more which are applicable to them all. A general proposition expressive of this agreement may then be deduced and applied to them without exception. Several such general propositions may be found to agree in some one or more points, and this agreement may be, therefore, expressed in a proposition of still more extensive application. Proceeding in this manner, from individual instances to general, and from general propositions to those still more general, we may finally, sometimes, reach propositions which include in their expression all substances on which experiment

can be made, or which observation can reach. Such a proposition, unlimited in its application, is called a law of nature.

At other times we find the proposition to be limited in its application, to one or more classes or orders of natural bodies.

We are said, in thus obtaining general propositions from individual facts, to employ the process of induction.

It is, however, impossible to collect every individual instance, and thus obtain complete proof of the general laws by induction alone. But we are warranted in concluding the truth of the proposition to be absolute, if we find it to apply to every case in which it is possible to make experiment or perform observation. We are now said to reason from analogy.

As an instance of the inductive process; of reasoning by analogy; and of the limit of some inductive propositions: I shall cite a very familiar case, drawn from Natural History, and partly connected with our most early impressions.

A child observes, that in his parents and play-fellows, the sensation of vision is operated by two concurring organs, and is not slow to become aware that he himself is similarly constituted. He finds the same provision existing in all the individuals of his race which he meets. He therefore infers, partly by induction, and partly by analogy, that "All men have two eyes." This is the first step in generalization, for until he had reached it, it would have been necessary for him to name the individuals in whom he observed the common fact.—He will probably have ascertained the truth of the same proposition, in respect to a variety of species of animals, but he cannot make the second step in generalization, until he have studied the elements of Natural History. He will then find that man, and all the animals in whom he has observed this peculiarity, belong to a grand division of the animal kingdom, which naturalists call the vertebrated, and will by two successive steps in the analysis—steps, we need not repeat here,—reach the most general proposition of all, namely: "*All vertebrated animals have two eyes.*" He cannot proceed farther, for he will find in other grand divisions of the animal kingdom, provisions totally distinct, or the faculty and organ wholly wanting; for, some animated beings have eyes innumerable, and others none. In reaching this most general proposition, he must have proceeded partly by analogy, and he can now apply the analogy to obtain even more extensive knowledge; for if he find, buried thousands of feet beneath the present surface of the earth, a fossil bone, although belonging to one of a family which has long since become extinct, he infers at once, that it, when living, had the same provision for receiving the impressions of light as existing vertebrated animals.

When a general proposition has once been obtained from individual instances by induction, we may, therefore, by analogy, make use of it to explain new facts, or to predict natural occurrences; we may also apply mathematical reasoning and calculation, and in either way may obtain propositions as certainly true as the result of the original induction itself.

We are now said to make use of theory; and although the term theoretic has been opposed to practical, as an epithet almost of reproach; it would were the individual to whom it is applied, worthy of it, be the highest possible praise; for it implies that he is acquainted with all known facts, as well as capable of applying them to discover new combinations, and to explain what has not before been observed.

What is styled hypothesis, is however, totally distinct from theory, and is liable to this reproach, for it is either founded on a partial view of facts, or has no other foundation, except that it is capable of explaining the phenomena which we observe.

In the course which I am now commen-

cing, I shall find occasion to illustrate these modes of reasoning, and explain these processes further.

Physical Science is, then, built upon the foundation of innumerable experiments and observations, and is made up of propositions of different degrees of generalization. In the study of this science, it is by no means necessary to pursue in detail the methods by which it was originally formed. To enter into all the experiments, would occupy, not the duration of a single life, but of several; and some of the observations may be of phenomena so rare as to be repeated at intervals too distant to be seen oftener than once in the course of several generations. It is only necessary that we should have reliance on the veracity of the observer in the latter case, or have concurrent testimony in the former. Thus when Hally observed a comet in 1759, his observations were received to be true; others of a subsequent generation revised his calculations and predicted its return for 1835. Living astronomers therefore looked for it with complete faith. This faith was fully warranted by the exact coincidence of the re-appearance with the prediction. So also, to draw an instance from another source, when many nautical men have informed us that they have met, in the ocean, with an animal as large as a ship, we see no reason to doubt their joint evidence, and receive the existence of the whale for a truth as well established, as if it were derived from the evidence of our own eyes.

If, then, it be unnecessary for us to repeat the experiments and observations of others, provided the truth of their results be established by sufficient evidence: Of what use, may it be asked, is experiment in a course of lectures on the physical sciences? The answer to this question is important in the present instsnce, as it will elucidate the plan which it is proposed to pursue. Experiments, then, are of importance, and in some cases absolutely necessary, in a well conducted course of philosophical instruction: First, because they bring our analogical reasonings and mathematical investigations to the test of the phenomena themselves, and thus enable us to perceive whether we have included all the circumstances of the case: Secondly, because they enable us to illustrate general principles, by means of particular facts; and to describe the individual instances, whence the general laws are deduced; and, thirdly, because they impress upon the mind more firmly, the recollection of the principles which they are applied to illustrate. It is also to be stated, that they afford an agreeable variety, and thus render a study attractive, by giving pleasure to the senses, which, in their absence, might be dry and laborious.

Such, then, are the views with which experiment will be introduced into the present course. The manner in which the general principles that will be developed were originally discovered, will be described in the way of history, and reference will be had to the distinguished philosophers, who have been authors of the several discoveries. To these we shall appeal as authorities, not however to follow with blind obedience, but with due regard to the evidence of the authenticity of their statements, and to corroborating facts. This authenticity we shall test in individual cases by experiment, and thus show the truth of the induction, by the exhibition of a few of the facts whence it was originally obtained; at other times, we shall have recourse to experiment, solely as an illustration of the principles laid down, or for the purpose of serving as an artificial memory.

For such experiments, liberal appropriation has been made, and it is hoped, that by proper exertions, the course may be rendered not only instructive, but interesting.

Having thus explained the method by

which the principles of physical science are originally obtained, defined the value and use of experiment in a course of public lectures, let us return to the consideration of the class of existences, the examination of whose phenomena is the object of Natural Philosophy.

We have already seen the impossibility of lifting the veil which hides from us the agency of the Maker of "this universe and all created things," and of penetrating to the final causes which operate in the constitution of the substances and actions, which become known to us through the intervention of our senses. Failing in this, we adopt the method of defining the object of which physical science more especially treats, by its properties. Choosing for this purpose those, which by the method of induction, can be shown to be universal, and omitting every property which is not common to every part of the visible world.

The existences, then, which we include under the general name of matter, are marked by certain obvious properties which are common to them all. These essential properties are but two in number, and are known by the names of extension and impenetrability. By saying that matter possesses the property of extension, we merely mean, that it must occupy a portion of space in all the three dimensions of length, breadth and thickness. By impenetrability we express, that it is capable of occupying this portion of space, to the exclusion of all other material substances, or in other words, that no two portions of matter can exist in the same space, at the same instant of time.

From the fact that matter is extended, it follows that it is capable of being divided; and discussions have been entered into, for the purpose of examining how far this divisibility may be carried. It is sufficient for our purpose to state, that it is believed at present, upon a variety of concurring facts, that matter is by division finally resolvable into portions which are incapable of further division. This proposition is not however, susceptible of absolute proof, for the actual division, by mechanical, physical, or chemical means can be carried to such an extent, that the sight, even when aided by powerful instruments, can no longer follow the operation.

The ultimate portions into which it is believed that matter is finally resolved by division, are called atoms, or, in more familiar language, particles of matter. If it be true, that no two particles of matter can exist in the same space at the same time, it follows, that before any particle can enter and occupy the place possessed by another, the latter must be moved from that place. Mobility or the capability of being set in motion is therefore, although sometimes reckoned among the essential properties of matter, no more than a necessary consequence of its impenetrabity.

Attraction also, which is often classed among the properties of matter, is not essentially so, for we can conceive matter to exist without it, which is not the case with the other two properties which we have named.

When we cease to consider matter in the abstract, and view it as it presents itself to our senses, we find it existing under certain determinate forms, or in peculiar and well marked states of existence. To these determinate forms and peculiar states, we give the name of bodies.

Bodies, as we find them on the surface of the earth, are undergoing continual changes, although with different degrees of rapidity. Thus some small animals are born, enjoy the functions of life, and die, within a few hours; and no sooner has their life departed than a decomposition begins, which resolves them back again into inorganic matter. Other animals, and some productions of the vegetable kingdom, resist for centuries the attacks of death, but are finally made subject to the same general law. Even the most solid rocks yield gradually to the principle of change, and generations of them

succeed each other in geological chronology, as those of men do in civil history.

In some cases, the disintegration is always attended by the destruction of the body, which the particles originally composed. Such is the case with all inorganic beings. But in the animal and vegetable kingdoms, although a waste of their particles is continually going on, this waste is supplied by the food which they consume, so long as the vital energy remains. In the youth of animals this supply exceeds the waste, and the body increases in bulk. In more advanced age, the waste and supply balance each other. Such is the extent of the change, which we are thus undergoing, that it has been proved by physiologists that at the end of seven years, no one particle which at the beginning of that period composed a part, even of our hardest bones, is left in the human body.

In all these changes, experiment and observation conducted with the nicest care, and strictest attention to weight and measure, have shown that not the smallest particle of matter is ever lost. It may be traced, forming in succession a portion of many different bodies, but in the innumerable changes of form, which proteus-like it undergoes, it still continues to exist, and to occupy its due extent of space, to the exclusion of all other material substances. The actions which we call natural, because they are due to causes inscrutable to us, operate with powerful, and in some cases, irresistible energy to produce changes in the constitution of bodies. We can ourselves, bring to operate on bodies mechanic forces, by which they may be rapidly disintegrated; and the actions of flame, of chemical affinity, and of other physical powers are still more efficaceous in changing the determinate forms in which matter exists at any given moment. But all these agents, natural, mechanical, physical or chemical, are wholly incapable of adding to, or diminishing in the least degree, the quantity of matter, which exists in the universe. Matter therefore, so far as any cause, which we can reach by our finite intelligence, is capable of acting upon it, is incapable of increase or diminution. It has therefore been inferred by some that it is eternal.

Persons of good intentions, but ignorant of physical science, have stigmatized the proposition of the indestructability of matter as Atheistic. So far, however, from being so, this very fact, is among the most powerful of the proofs of the existence of a deity, which natural theology brings to the aid of revealed religion. We cannot conceive of the existence of any thing without an adequate cause, and this truth is admitted under the name of the sufficient reason, both by infidels and believers. If then no finite cause be sufficient to generate material existence, it necessrily follows, that all which we see or discover by our other causes, in the universe, must be the work of an omnipotent cause,—the creation of an agent of infinite power. If his workmanship be eternal, so must he also be; and of his wisdom all nature furnishes abundant proof. If on the other hand the present state of things is ever to be brought to a close, it can only be so, by the same Almighty power, to which its original creation was owing.

The motion which bodies acquire, in consequence of the impenetrability of the matter of which they are composed, is subject to certain definite laws. The study of these, and the application of them to predict and explain natural phenomena, and to direct the works of human art, is the province of an extensive division of Physical Science, to which, from the intimate relation it bears to the practice of all the arts, the name of Mechanics' has been applied.

Mechanics' differs from the other divisions of natural philosophy, in approaching more closely to the rank of an exact science. The laws which govern the action of the forces by which motion is produced are few; and are reached by the most simple induction. Upon these laws a science of vast

extent and almost unlimited application, can be built by the aid of mathematical reasoning alone. So completely is the mode of proceeding identified with that employed in pure mathematics, that the original induction is often passed by unnoticed by such as content themselves with the mere theory. When, however, this theory is to be applied to practical purposes, innumerable experiments become necessary, upon friction, the strength of materials, the resistance of fluid media, and other interfering causes. Such however has been the extent of the researches into these subjects, and the accuracy of the mathematical laws which have been deduced from them, that it is hardly possible for a new case to occur in practice. We can calculate the power, and forsee the action of a machine, determine the proper dimensions of the parts of a proposed structure, or predict the quantity of water which will be delivered by a pipe, although miles from the source may intervene, with almost as much precision as we can estimate the number of square feet in the floor of a room.

Situated, as we are, upon the surface of a body which we call the earth, our position causes us to draw a wide distinction between the bodies which we find in our own immediate vicinity, and those which our sight teaches us, to exist in distant parts of space. The appearnces of the latter bodies, to which we have given the name of heavenly, are pursued by a species of observations which we style Astronomic. To the astronomy of observation it is necessary to call in the aid of mathematical calculation; and we obtain by their union the science of Theoritu and practical astronomy, the most elevated of those included under the general name of Physical.

The laws which govern the motion of the heavenly bodies, are shown by this science to be identical with those which are involved in the motion of terrestial bodies. The motion of the ship upon the ocean, of the carriage upon the railroad, and of the manufacturing machine, are all subject to exactly the same rules as those which guide the planets through the regions of immeasurable space. When we apply these laws to the heavenly bodies, we create a science to which the name of celestial mechanics' has been given. This also goes in our language, although with little propriety, under the name of Physical Astronomy.

In the motions of bodies, in the changes which they undergo, and in some of their mutual actions upon each other, we perceive the influence of agents which cannot themselves be embodied or confined; and which therefore, although acting powerfully on matter, we cannot prove to be material. Among such agents are, heat, light, electricity, and magnetism. The investigations of the effects produced by them, and of the manner in which they act upon bodies, gives birth to a department of Natural Philosophy, to which the name of Physics is usually restricted.

The bodies which we meet with in nature are rarely simple in their constitution. Each of them is generally capable of being resolved into two or more other bodies of greater simplicity; and by means, whose manner of action we shall have occasion to study, bodies are finally reached, which it is impossible for us, in the present state of our knowledge, to simplify further. These simple bodies may again be re-united, and thus caused to regenerate the body whence they were originally obtained, provided it had not been organised. In the combinations which these elements thus enter into, they are found to be subject to a few determinate and definite laws. The study of these laws, and of the natures and characters of the substances themselves, is the province of another department of Natural Philosophy, which is known under the name of Chemistry.

Such then is the basis of the division of the general subject of Natural Philosophy, into distinct sciences. And it may not be amiss to repeat their names, along with a

more brief definition, in order to impress them more fully upon the minds of such portion of the audience as has not yet entered upon the study of these subjects. The divisions of Physical Science, then, are :

1. Mechanics, which treats of motion in general, as well as of the construction of machines, and other artificial structures.

2. Astronomy, which observes the motions of the heavenly bodies, and by the application of mathematical calculation to the records of the observations, enables us to predict the occurrence of the several phenomena.

3. Celestial Mechanics, or Physical Astronomy, which applies the laws discovered in the motion of terrestrial matter, to the explanation of the phenomena of the heavenly bodies, and to the detection of minute variations, growing out of their mutual action, which can hardly be reached by observation alone.

4. Experimental Physics, which is generally restricted to the examination of the actions, and effects, of light, heat, electricity, ard magnetism.

5. Chemistry which investigates the compositions of bodies and inquires into the nature and character of their elements, and of the several compounds which these elements make up. However different these subjects may be from each other, there is, notwithstanding, an intimate connection between them all, and it is indeed hardly possible to make progress in any one of them, without at least a partial acquaintance with each of the others. Nor is it practicable in almost any case, to produce a natural effect, in which actions which are included under at least three of the different heads, are not intimately connected. The three species of action which are thus closely allied, are the mechanical, the chemical and the physical. The agent, too, by which the motions of the heavenly bodies are controlled, is of the same general character as those we call physical; and were it not that we rather study it in its great mechanical effects, than in its mere laws, might be classed with electricity and magnetism.

A simple instance will serve to exhibit the connection, as well as to illustrate the difference, between these several kinds of action.

A smith places a piece of iron in his forge fire and heats it red hot; applying for the purpose the *physical* agency of heat. He next lays it upon his anvil and beats it into some proposed form, the action thus applied is strictly *mechanical*, not only in common, but also in scientific language. But while he beats the red hot metal, sparks fly off in all directions, which are the result of the combination of the iron with one of the component parts of the atmosphere, a combination which is therefore governed by *chemical* laws. We might go farther, and show how the combustion of fuel, urged by the action of a bellows, whence the heat is originally derived is due to another combination of mechanical, physical and chemical action, but what has been already said will suffice for our purpose.

It has already been stated that it is my intention to select from the wide field of which an outline has now been given, a few subjects susceptible of familiar explanation, and popular illustration. I have been farther guided in the choice of these subjects by the desire to exhibit those particular points in which Mechanics, Physics and Chemistry are more closely connected with each other. The course will commence with a general view of the classes into which bodies are divided, by means of their mechanical characters. Among these we shall find that the class to which the atmosphere which surrounds our earth belongs is the most curious and interesting. We shall therefore enter fully into the investigation of its nature, and mechanical properties. At every step we shall find that these properties are materially influenced, if not wholly due, to the physical agency of heat. The consideration of the

effects of heat, and the laws by which it is governed, will therefore naturally follow.

Returning again to the atmosphere: its chemical character will be examined, and the manner in which it can be separated into a number of constituents, described. The most important properties of these constituents, and of the elements analogous to them in character will then be illustrated by experiment. In the course of these experiments, we shall be led to the consideration of the more important principles of physical science, and finally to the discovery of the laws of chemical affinity, with the consideration of which, the course will conclude.

It is hardly necessary that I should point out to this intelligent audience, the advantages to be reaped from the study of the physical sciences. Derived, as they are, from the careful observations of the action of nature, continued for several generations; and composed of laws and principles deduced by laborious study from innumerable facts, these sciences possess the merit of conveying to him, who wishes to enter into the practice of any of the useful arts, the accumulated experience of centuries. If therefore, it be not only possible, but a fact of daily occurrence, that a person, by practice alone may become eminent, in the manipulations of manufactures and the mechanic arts, he may save himself much labor, both of body and mind, by acquiring the principles of physical science, before he enters upon the manual part of his calling. These principles will enable him to foresee contingencies in the exercise of his art, which he might otherwise only learn by long and laborious experience. The difference in the progress of him who rests upon physical principles as the guide of his practice, and him who is unable to employ them, will be in some measure the same, as that which exists between the persons by whose researches the fabric of Natural Philosophy was erected, and those who study it in its present state. The investigations of the former have continued undisturbed, and in regular succession for more than two conturies, yet to a youth of intelligence and duly grounded in elementary knowledge, a couple of years may well suffice for the attainment of a complete outline of the sciences. The knowledge, too, which is acquired in the study of science, is capable of universal application, while that which is derived from practice alone, is of little value, except in the epecific case in which the experience was obtained. It is true indeed, that theoretic knowledge can never be a substitute for practical skill, but a far higher degree of that skill can be acquired, by him who is previously imbued with a knowledge of the physical science, than by him who is devoid of it. The cultivator of science and the practical man, ought therefore, in order to a complete success in their respective callings, to start from the same point. Both should be equally versed in the elements of natural philosophy. Their paths will then diverge from each other; the one will devote his whole time and attention to the increase of the facts of the science he studies, or to the extension of its theoretic parts. The other will apply the knowledge he has obtained to practical purposes.

In their subsequent course, each may mutually aid and assist the progress of the other. It has in fact been observed, that the man of science can hardly enter the workshop of the artisan, or view the machinery of the manufacturer, without learning some new fact, or perceiving some application of well known principles, to purposes entirely novel; and thus the actual progress of physical knowledge, may be often as much promoted by the mere workman, as by him who devotes himself wholly to abstract studies.

It is not the less true, that the working-man who has acquired his whole skill in

the exercise of his art, can hardly listen to a scientific disquisition, without acquiring ideas, which, in the possession of the theorist, have remained without producing fruit but which, when once suggested to a practical man, are found capable of rendering important service in the useful arts.

Instances of these two cases are too numerous to be cited. One of each description will suffice to illustrate our position.

The machine invented by Babbage, for performing by the mere revolution of wheels, calculations, which have hitherto demanded the whole effort of numerous arithmeticians, had at first a defect, which in spite of the perfection of its principles, would have rendered it wholly useless. This defect will be understood by those who are aware, that in writing out, or printing a series of decimals, limited to a given number of places, it is necessary to change the last figure in certain cases, for that which is next higher in the scale of numbers. If, then, the instrument could not have been made to perform this operation, it would have been unfit for practical purposes. An intelligent workman, who was employed in fitting up a model of the machine, becoming aware of the difficulty, speedily suggested an appropriate remedy.

The instance of the opposite description, is said to have occurred among ourselves, and although I am unable at a distance of nearly twenty years, from the date at which it took place, to mention names or refer to authority, I believe the anecdote to be authentic.

A young hatter of this city, became an attendant on a course of chemical lectures. Previous to that time, the felt, of which the article he manufactured is made, had been stiffened by common glue. This substance being soluble in water, the hats stiffened by it, became soft when exposed to rain, and disagreeable both the sense of touch and of smell. In the course of his chemical studies, he became acquainted with a substance wholly insoluble in water, but which, when dissolved in spirits of wine, possesses the same properties in causing adhesion, as glue does. He therefore determined to try it in the practice of his trade, and was fully successful. Here then, we have an example of a practical man, acting upon a slight hint, derived from a scientific source, as in the former case, we have an instance of the completion of a strictly scientific discovery, by the clear perceptions of an operative mechanic.

Thus the man of science, and the man of skill, derived from practice, may materially subserve each others purposes. But a far greater benefit to himself and the world, will accrue, when the practical man, shall add to his manual dexterity, and experimental skill, an accurate knowledge of the fundamental truths of science. In this respect he possesses a vast advantage over the student, who confines himself to theorectic discussions. The very character of the labors of the latter, are often such as to unfit him for manual dexterity, while the former may make the exercise of his art, a school of practice for his scientific acquirements.

In spite of this advantage which the operative man possesses, it unluckily happens, that a popular prejudice, seems to oppose the application of his time to scientific studies. Strange as it may seem, he who has acquired the very surest foundation for the attainment of practical skill, is often spoken of slightingly, because he possesses that foundation. Even men, in other respects intelligent, often lend themselves to the unworthy prejudice. The present occasion affords a presage that this prejudice, shall no longer operate in the city of New-York. The general Society of Mechanics' and Tradesman, after having completed, on the most liberal scale, an Institution for imparting elementary education, is now in the act of opening its halls to scientific instruction. In the course of the present year,

little can be attempted, except to excite curiosity; but when that is once aroused, it is hardly possible to anticipate the progress which the student may make. For the gratification of such laudable curiosity the present occasion is an earnest that the enlightened directors of the Society, will henceforth furnish all the requisite means.

Of the advantages which have resulted from the united application of science and practical skill, a few instances may be cited which are too interesting to run the risk of appearing tedious.

A man now spins by the aid of engines, founded upon scientific principles, and constructed with the most consumate practical skill, one hundred times as much yarn as he formerly could have done, even with the help of a machine; and there are simple manufactories, in which the quantity of yarn produce daily, would extend a distance equal to twice the circumference of the globe or 50,000 miles. The art of weaving has improved in a similar degree, and a girl can now direct power looms, which formerly demanded the labor of six strong men. In single weaving establishments, a piece of cotton cloth has been turned out finished every fifteen minutes, or upwards of fifteen miles in a day. The great agent in all these operations is the steam engine, and it has required to bring it to its present state, the most remarkable combination of knowledge of the physical sciences, of skill in the mathematical theory of mechanics, and of manual dexterity which has ever been called into action. In its existing form, and it is still susceptible of improvement from the continued application of the same means which have brought it to its present state, it has multiplied the time of man, and given a substitute for the labor of millions.

Such improvements in the arts, not only add to the general prosperity, but conduce to private comfort, and promote individual happiness. Of this, none are better qualified to judge than the audience here present, who have the good fortune to live in an age when all the mechanic arts, have been brought, by a skillful application of science, to a state of unexampled perfection, and in a city where a successful commerce enables us to make the most distant regions of the Earth, contribute to the supply of our wants. This commerce also, be it known, has derived its prosperity as much from the scientific skill of a Bowditch, and the geometric knowledge of an Eckford, as from the boldness of our nautical men, and the enterprize of our merchants. For us, the silk worms of China, Italy and Provence, spin their strong and delicate webs, and the looms of Nankin, Florence and Lyons, labor. For us, the sheep of Saxony and Spain, are shorn, and the clothiers of Louvain and Gloster, ply their shuttles; for us the cotton of Georgia, and Bourbon, is rolled upon the spindles of Manchester and Rouen; for us, is raised the hemp of the Ukraine, the flax of Munster, and the sweet cane of the Indies; for us, bloom the spicy forests of Sumatra and the Molucca, and the coffee gardens of Yemen, Java, and Cuba; to close our apartments, we interpose screens of transparent glass, pervious to the light and the colorific rays of the sun, but impervious to the blast, and retentive of the grosser heat which our skillfully constructed furnaces yield; and in order to extend our hours of day light, for circumstances will justify the term, we cause gases to circulate in our streets, as the vital fluid does through the veins and arteries of the animal frame.

Mere physical enjoyments, however, are not the sole objects of advance in science. Such studies would be pursued with but little advantage to the true interest of mankind, did they not, at evey step, unfold to our view more and more of the consumate skill, unwearied goodness, and unlimited power of the creator. Our studies, then,

if they could never have served as a substitute for revealed religion, may be made to render it an efficient aid, and, by bringing the book of nature forward as a commentary upon that of revelation, may help to confirm our faith, and strengthen our hopes of immortality.

Items.

M. Thenard has resigned the Professorship of Chemistry at the Ecole Polytechnique, and it is expected that he will be succeeded by M. Dumas.

The suspension-bridge of Meung-sur-Loire, in the department of the Loiret, has just been opened to circulation.

A physician of Rochfort has invented a means of protecting men working at wells against the falling in of the earth, and which he calls *Puits de Sauvetage.* He has generously printed a description and plan of his invention, and sent a copy to the principal town of each department.

A colossal statue of Jean Bart, in stone or marble, is about to be erected, by subscription, at the entrance into the port of Dunkirk.

The numbar of passengers last month by the Antwerp railroad, amounted to upwards of 90,000, and, but for the bad weather, it is believed it would have been more than 100,000.

The Geographical Society has received a letter from M. Derius, captain of a merchant vessel, givtng the following account of his having discovered a new Island:—"On the 27th December last, having entered the dangerous Archipelago of the Society Islands, and having touched at Gambier's Island, I was making way for Hood's Island, when at 10 in the morning, being to the south of this Island and keeping a westerly course, the man at the mast head gave the cry of "*Land to the larboard.*" This surprised me, as none of the charts lay down any land in this direction, at least in this latitude. I steered towards it, and by two o'clock was about two miles from it. I found it to be a low island about twelve miles in extent; well wooded towards the centre, and the Northern and South-Western extremities furnished with cocoa-trees. I could not discover any traces of inhabitants, nor any boats or canoes along the coast. I ascertained its position to be 21 degrees 59 minutes south latitude, the point to the North, and 138 degrees 32 minutes mean longitude West. I do believe that this Island has never been named."

The mummy of an Ibis contained in an earthen vase was unrolled a few days since at Carlisle. The mummy, when taken out of the jar, looked like a mass of linen firmly bound together. The outer layers of cloth were of fine texture; the inner layers of a coarser quality. In some places about thirty thichnesses of cloth were numbered, and of eight different degrees of fineness. Some of the bandages were circular, others longitudinal. Some of them appeared as fresh as new cloth, and some appeared old, much worn, and sewed in several places. Five different kinds of sewing were observed—some of which exhibited beautiful specimens of needlework, and although perhaps three thousand years' old, would bear a comparison with needlework of the present day.—[Observer.]

M. Grille, Librarian at Angers, has just become the possessor of a rare historical treasure, consisting of 40 sacred and other utensils, in duplicate. These vases are ornamented in the inside with religious and symbolical designs, with a frame-work of silver mirrors. There are also nine masks of Pagan Divinities, in the purest silver, and a key admirably carved in bronze, which would appear to be that of the *sacellum,* or small Roman temple, to which these objects probably belonged. The whole of the articles, which were first discoverad by a working man, are of most beautiful form, and in a state of perfect preservation. M. Grille has refused to sell them at any price, and, with a generosity which does him honor has presented them to his native town.—He is at present occupied in writing an archeological notice of the objects of this interesting discovery.

One of the most complete organs we ever heard has been built by the excellent workman, Gray, on an extensive scale, for Trinity Church, Boston, in America, by the direction of the Rev. Dr. Wainright, who is at present in England. The diapasons of this fine instrument are voiced in that peculiarly round full tone, for which

we think Gray unrivalled. The great organ has a splendid trumpet stop, and a power which is divested of all harshness ; and the swell is a compound of extremely sweet stops, effective together, and equally so in detail. There is one stop on this organ, the quality of which is between that of the *stop diapason* and flute—it is called the *clarabelle*, and we do not remember to have heard a stop of equal beauty in any other organ.—[Atlas.]

A patent drag, or coach-retarder has been tried, during the last few days at Highgate-hill. The principle of this machine is, that by increasing the pressure on the boxes of each of the hinder wheels, the friction is increased to such an extent as to stop the progress of the vehicle. This is managed by means of a lever with springs acting above and below the box of each of the hind wheels, and can be very easily applied by any person on top of the coach. The trial was perfectly satisfactory, as the machine stopped the coach instantly while going down hill at a considerable speed.—[News.]

The minister of Public Instruction in Russia has lately ordained that there shall be established in all the Universities, Gymnasiums, and Lyceums of the Empire, classes for forming young men for merchants, mechanicians, chemists, and for every other branch of commerce and the useful arts. Another ordonnance decrees that there are to be in the gymnasiums of Siberia, as well as in the cantonal school at Stavopol, a section expressly for the children of persons employed under the Government, who are to be educated at the expense of the State, but on condition that they will serve for six years, without any salary, as servants of the Government in the provinces in which they have received their education. By this system, the Government gains a double object. It in the first instance qualifies persons for filling its offices, and in the next ensures a supply of men of capacity for places which have hitherto been only accepted by ignorant persons, because those who were well informed were unwilling to go into a sort of banishment in Siberia.

We have received the following particulars relating to the stellar phenomenon we lately noticed :—From 8 in the evening of Friday till half past 6 in the morning of Saturday, observations were taken by men of science, of which these are the results.—One hundred and fifty stars were seen darting about like the sparks of artificial fireworks. This number, however, is much less than those which have been seen in former years, and in other parts of the globe. The phenomenon appeared in all points of the sky, but chiefly in the constellations of the Lynx, Leo Major, Leo Minor, Ursa Major, the Cameleopard, and Cyrius. Every year, about Nov. 13th, the earth and a mass of agglomerated asteroides, or small stars, meet at the same point. These stars are attracted by the sun and the earth. The power of these two attractions brings them near our atmosphere, where they become ignited in their passage. The want of proportion between their extreme velocity and that with which our globe changes its position, frequently causes them to escape the attraction of the earth. Being then launched into the immensity of space, they continue making a circuit round the sun different to the former. To those which fall upon the earth have been given the name of *Aereoliths*. According to calculations formed upon the system of Parallaxes, it has been estimated that some of these are equal in size to the building of the Val de Grace.—The most considerable of all that have been examined after their fall have been found in America. It weighed 30,000 lbs.

The steeple in which the bells of the Church of St. Julien de Mailloc, at Lisieux, in Calvados, are hung, was raised above the centre of the building It was wished to remove it over the principal entrance, a distance of 65 feet. The height of the steeple is 400 feet from its base, which was 25 feet above the pavement of the church to its pinnacle. This task was undertaken by two carpenters, M. Nicolle, of Courson, and M. Lami, of Lisieux, and accomplished in the following extraordinary manner. The entire steeple, with the bells in it, was first raised 15feet perpendicularly,and then moved horizontally from its old to its new position, without any scaffolding being raised, the lateral walls of the church being made to serve the purpose of a plane on which to impel it. It marched steadily and majestically along, the bells being not only left in their places, but actually rung during its progress. The whole cost of this bold undertaking was *two hundred and fifty francs !*—so says the

Pilote de Lisieux, from which we take this account.

The *Frankfort Post-Ampt Gazette* gives the following, from Hohenzollen-Sigmaringen:—"In the course of last summer the Pastor Stehle, minister of the parish of Borenthal, discovered at the foot of Mount Henberg de Sigmaringen a grotto, 400 feet in length, and extremely remarkable both in a geological and geognostical point of view. The entrance is situate towards the east, amongst rocks, from the fissures in which grows a quantity of box-wood. The grotto contains a species of hall, 100 feet long, in the direction of the west; this hall communicates towards the south with another division, also 100 feet in length. The sides, which are formed of snow-white stone, are marked with regular excrescences in the form of drops, and resembling ornaments, executed with taste and care. A third large hall, which is also 100 feet in length, communicates with the preceding by a large and lofty aperture extending from east to west. The *ensemble* of these halls resembles a gothic church with a part of the dome in a delapidated state. In the direction of the south is a wide fissure, which forms a sort of well 150 feet in depth, and in which have been found human bones, and those of inferior animals. M. Stehle has called this Grotto Carlshœhle (grotto of Charles,) after the name of his Sovereign. On the same level are three other grottos, distant from each other only two leagues; that of Carlshœhle, as we have above stated, is 400 feet long; the grotto of Kœnigsheimer is 318 feet in length, that of Kolbinger 400, and that of Mulheimer 350 feet."

Yesterday a meeting took place at the workhouse in Poland-street, to witness an exhibition made by Mr. Ford with his improved fire-escape, at the request of the overseers of St. Jame's Parish. Mr. Ford's simple apparatus consisted of a plain spar, about thirty feet high, which, being raised and inclined against a house, allows an apparatus, called a traveller, to which a portable and convenient seat is suspended, to run up and down, by means of a rope passing through a block at the bottom of the spar. Many ascents and descents were made with great facility and safety, and the operation of the machine appeared to give great satisfaction to the persons assembled among whom were the Secretary and some of the most active members of the Society for preventing loss of life by fire, as well as several scientific individuals. Mr. Ford's fire-escape was first brought out at Liverpool, and has been since approved of, and adopted by the Commissioners of Woods and Forests. At the same time Mr. Wivell exhibited another apparatus in the adjoining street. Mr. Wivell's fire-escape was formed of a two-storey ladder, beneath which, was placed a canvas trough; a second ladder joined on to the first communicated at the same time with the windows of the third floor. The whole was mounted upon three wheels, and the arrangement altogether displayed a good deal of ingenuity. A great number of descents were made in rapid succession, the progress of the lads in sliding through the canvass trough afforded much amusement among the immense crowd which had collected to witness the novel sight. The principal objection of Mr. Wivell's plan seemed to be its cumbersome charater.—[Herald.]

The *Toulonnais* gives a letter from M. Mimaut, the Consul at Alexandria, containing the following description of some of the articles forming his collection:—"1. The four large funeral vases of alabaster which ornamented the tomb of Psammeticus II.—2. A statue, larger than life, of the Historian Heridotus, in Parian marble, found in the ruins of the *Panium* of Alexandria.—3. A bronze statue of Antinous, from the ruins at Zifteh.—4. A truncated column in red granite, bearing the monumental inscription of the Quarries of Syena, which have given rise to a very learned dissertation by M. Batrame, in his *Recherches pour servir a l'Histoire de l'Egypte*.—5. A bronze vase bearing the attributes of Bacchus. From the perfection of the workmanship, it has been considered as coming from the hand of Lysippus, who was founder to Alexander the Great. This composition has been reproduced in marble in the colossal vase known as the Warwick vase. From the place in which this was found, it is believed that it has lain in concealment ever since the close of the dynasty of the Lagides.—6. The genealogical and chronological table of Alcydos, discovered in 1818 by Mr. Bankes; so deeply studied, and well-explained and commented upon by M. Champollion, and which is considered as the most interesting and valuable monument extracted from the ruins

of ancient Egypt, since the celebrated stone of Rosetta." M. Mimaut adds: "The sands had coverd up this invaluable record (the Genealogical Table.) The searchers for stones and other materials have regarded them as things without value, not belonging to this class of monuments, until, in consequence of a memorial from M. Champollion, and at my express desire, the Veceroy gave orders that they should be respected, under the severest penalties, orders which have saved the great Temple of Denderah, and which he has lately renewed with the intention of forming a museum himself at Cairo. This decision, come to somewhat too late, amounts to a prohibition against the exportation of any more antiquities, or remains of the ancient arts. My right to an exemption has been allowed. In fact, Mehemet Ali anticipated my application. This, however, I do not take to myself personally, but consider it as a mark of consideration for France."

The Minister of the Interior has ordered of M. David a bust of Laurent de Jussieu for the Institute, and of M. Mercier a bust of Carle Vernet for the Academy of Fine Arts. M. Guyot, of Lyons, has also been ordered to execute, for the Museum of that town a bust of Dugas Montbel, formerly a deputy, and the translator of Homer.

A company has been formed at Liege for an establishment of Steamboats on the Meuse, between Liege and Namur, and two vessels are building, which will begin running on the 1st of May. The passage from Namur to Liege will be performed in three hours, and back, a gainst the stream, in three hours and a half.

A new suspension bridge over the Loire at Digoin, on the departmental road between Moulins and Macon, was opened on the 22d ult. Another similar bridge at Fourneau, between Moulins and Bale, is very nearly finished.

On Monday a singular discovery of a seam of coal was made in Berwick.—While some alterations were being made in the pavement, at the depth of about six inches from the surface, the workmen came upon a seam of coal, which measured three feet one inch in thickness. The quality has been put to the test, and is pronounced excellent.—[Berwick Advertiser.]

During the last three or four days, men have been employed in covering the surface of the Obelisk with a concentrated solution of caoutchouc, or Indian rubber, in order to preserve it from the effects of the air of the climate, which is injurious to the granite of Egypt, although the granite of this country is not in the least degree liable to be effected after an exposure for ages. The quantity consumed in this operation will be about 84 quarts, and the surface to be covered is about 190 square yards.

The *Constitutionnel Neuchatelais* announces that M. Descombes, a young man only 19, has lately discovered a means of adding to escapement-watches an independent second-hand without the addition of a separate main-spring, and the wheels connected with it, which so greatly enlarged chronometers, and crowded them with a number of wheels, which will now become unnecessary. By a duplex-escapement, arranged in a new manner, M. Jacot, has obtained independent seconds as precise as by the old system.

Extract of a letter from Rome :—" We have been to Corneto to see a magnificent tomb, discovered by M. Bucci, who was formerly a draper, but has left dealing in clothes to bestow the whole of his time upon antiquities, having formed a passion for ancient vases. On arriving at Corneto we found an immense necropolis or cemetry as extensive as that of Pere Lachaise. The tombs are small, under-ground chambers or vaults, about 12 feet long by 8 wide, covered with the earth to the depth of 3 feet, so that in order to reach the entrance an excavation of from 10 to 12 feet in depth is necessary, They are found to be filled with black and painted urns. Sometimes the walls are found to have been painted, but this soon disappears after being exposed to the air. The King of Bavaria, has had many of these paintings copied by M. Ruspi, who has, in accomplishing his task, shown great talent. Lately a vase was found worth 60 louis, it was presented by M. Bucci to the Pope. To obtain a perfect vase, it is sometimes necessary to search amongst the fragments of betweenn 30 and 40 that have been broken. They are all anterior to the foundation of Rome.

The Cabinet of Medals at Madrid contains 90,227 pieces, of which 2.672 are in gold, 30,692 in silver, 51,186 in copper, 366 in lead, and 50 in wood ; 835 casts in

wax, and 336 in gypsum. They are arranged in 1439 cases.

Stage-Coaches were first introduced into Scotland in 1678. On the 6th of Augu t, in that year, the magistrates of Glasgow contracted with William Hume, of Edinburgh, that he should run a coach between Edinburgh and Glasgow,—forty-two miles. Hume engaged with all diligence to run a coach with six able horses, that should " leave Edinburgh every Monday morning, and return (God willing) every Saturday night !"

French Steamers.—A grand French enterprise of steamers in the Mediterranean is nearly completed. Ten of them each 500 tons, and magnificently fitted up on English models, are in the port of Marseilles, ready to commence the service.—There are to be two lines, one from Marseilles to Constantinople, the other from Athens to Alexandria. They will intersect each other at the little island of Syra, and exchange passengers and despatches. Between Marseilles and Constantinople they will touch at Leghorn, Civita, Vecchia, Naples, Messina, Malta, Syra, and Smyrna. The departure will be so managed that three times per month three steamers, one coming from Marseilles, the second from Constantinople and Smyrna, and the third from Alexandria, will arrive at the central station at Syra; so that a person at Marseilles can receive on the 29th day an answer to a letter written to Constantinople or Alexandria; while at present forty-five or fifty days are employed in going and returning between Marseilles and either of those places.—[Sunday Times.]

Paddle-Wheel Experiment.—A recent experiment has proved that the supply of water to the paddle-wheels of steam-vessels does not come from the surface of the water, or from the sides of the space through which the wheel moves at each evolution of the water, but from beneath. It was proved as follows :—A steam-vessel was moored at deep water, which was strewed (it being calm weather,) with sawdust; the engine was then put in motion, and it was observed that the sawdust all around and every where, except immediately behind the paddle-wheels, remained undisturbed.—[Times.]

Colossal Statue of Shakspeare.—Dr. Carpue lately at the Western Literary Institution, Leicester-square, stated to the audience that he had an important communication to make on the subject of a statue to Shakspeare, the largest statue ever erected to an individual. The King had consented to be the patron, and the Queen the patroness of this plan. The statue to be raised on an elevation 200 feet above the level of the Thames. The pedestal to be 60 feet, and the statue 80 feet high. It was also projected that there should be a starcase by which the curious might ascend to the crown of Shakspear's head ; that there should be built near the statue a house, a *fac-simile* of that in which it is assumed Shakspeare was born, for the residence of the person who should be engaged to show the statue : and that such residence should be allotted to a female descendant of a sister of Shakspeare now alive, but who is in very humble circumstances, and who should also derive any benefit that might accrue from showing the statue. He further mentioned, that the expense would be 20,000*l.*, to be raised by subscription ; but that no one was to subscribe more than one guinea. For such an object, and that was to be so productive of immediate benefit, he doubted not, that there would soon be an adequate amount of subscription. The communication, after surprise had somewhat subsided, was greeted with very enthusiastic applause. The Doctor did not say how the descendant of the Shakspeare family was in the interim to be taken care of, nor did he mention when the projectors and calculators expected that his colossal statue might be completed.—[Morning Herald.]

Antiquities.—In the department of the Nievre there have been discovered two coins remarkable for their rarity. One is of Charlemagne, bearing the legend *Carlus Imp. Aug.*, and on the reverse *Nevernis Civit.* ; the other is of Rodolph, and has the legend *Rodulfus Rex.* ; on the reverse, *Nevernis Civit.*—There has lately been found in a field, near the old Roman road, leading from Reims to Verdun, a small vase, containing 616 silver coins ; of which 290 are of the period of the consulute, and belong to at least 150 families ; 4 of Pompey the Great ; 11 of Julius Cæsar ; 22 of Marc Anthony, 6 of which have the profile of Cleopatra on the reverse ; 3 of Lucius Antonius ; 1 of Lepidus ; 165 of Augustus,

and 20 of Tiberius. They are all in a high state of preservation. An antique patera said to be extremely curious has lately been found at Mouchenot, near Reims. The bottom is richly chased in bas-relief in three compartments, representing several female figures, and executed with great taste.—They are supposed to represent the emblems of marriage. It has been purchased by an English antiquary. Last week at a short distance from Arles-sur-Aube, on the road from Arles to Troyes, in a piece of ground, supposed to have been used as a cemetery before the establishment of christianity, vases of different materials and forms, amulets, Roman medals, and the entire skeleton of a human being, which appears to have been embalmed, and in or near the hand of which was an obolus, placed there for the purpose of paying Charon for ferrying the soul over the Styx, have been lately found, and proved that the tradition was well founded.

M. Dubrunfaut, who discovered the existence of potash in molasses, is at present in the department of the north, where he intends to form an extensive establishment for the purpose of turning his discovery to account. This establishment, in which will be consumed all the molasses from the sugar-manufactories of the north, will annually produce 300 pipes of spirit, and 1,000,000 kilogrammes of potash.

Iron, after remaining a long time submerged in the sea, is converted into Plumbago. As an evidence of this change, M. Eudes Deslongchamps has lately presented to the Linnean Society of Normandy some cannon balls taken from the bottom, off Cape la Hogue, which were sunk with the ships under Adm. Tourville in, 1792. They do not at first sight appear to have undergone any change; but, when examined, are found to have lost two-thirds of their weight, and may be scraped or cut with a knife, like black lead. They contain no remains of their original ferruginous qualities, and have not the least effect upon the loadstone or magnetic needle.

The subject of Steam carriages on common roads, has excited little or no attention with us. In England the case is different; experiments have been made, and continued for years, and the subject is growing to be such an important one, that the question of tolls upon such vehicles has called forth a vast deal of excitement among those interested. The following minutes of evidence on that subject, are taken from the London Mechanics' Magazine, as we find them. We hope the length of the article will not deter any one from reading it, containing as it does, the best information of the practical operation and every-day work of their machine. Many useful hints may be found, and the amusing style of question and answer, take much from the dullness of the detail.

From the London Mechanics' Magazine.

MINUTES OF EVIDENCE BEFORE A SELECT COMMITTEE OF THE HOUSE OF LORDS ON THE TOLLS ON STEAM CARRIAGES' BILL. SESSION 1836.

MR. GOLDWORTHY GURNEY

Has had no engine on the road since 1831; before this period they ran a good deal in the neighborhood of London. Went to Bath and came back in 1829. Carriages in 1830 were established between Gloucester and Cheltenham, and ran there uninterruptedly for four months three times a day. They carried upwards of 4,000 persons over 5,000 and 6,000 miles of ground without any hurt or accident. And not running on that road now, because they were stopped by turnpike acts, which laid a toll of 11s. each time of passing at both gates, a distance of eight miles, making 22s for each journey.

His carriage can be made to run round a circle of twenty feet diameter, at a speed of six or seven miles an hour.

Cannot say exactly how many miles his carriages have run along public roads; but should think 15,000 miles.

Has not built an engine, nor had any one on the road since 1831.

Thinks that if his carriages had gone on and been persevered in they would have prevented some of the railroads now in operation. Is quite satisfied of that. By a little experience and management, steam carriages will go nearly as fast and fully as safe on a common road as on a railroad. After a twelvemonth or two years observation the public would be satisfied with them, and a rapid rate would be permitted. It is rather a singular fact that when you are travelling at the rate of eighteen miles an hour in a steam carriage on a common road you are not sensible of the rapidity.

Have you ever travelled eighteen miles an hour in a carriage on a common road?—Yes, I have gone eighteen miles within an hour.

From what place?—From Finchley to Regent's Park and back again twice, up the Highgate Tunnel. We travelled the first twenty-four miles in two hours in our journey to Bath.

Have all the boilers tried on common roads been attended with loss of life, if constructed above a given size?—I would not say that all have, but all I am acquainted with.

What is the extreme size you would recommend?—The extreme size for public safety I am of opinion ought not to exceed eight or nine inches diameter. I think it essential to keep within that size; they may be reduced still lower. I am sure all engineers of experience would bear me out in stating that this size is sufficient for all purposes on common roads.

The Committee are to understand that your carriage, though less in weight, has *more power* than the locomotive engines employed on railroads?—Yes, compared to weight; on a railway they are very heavy.

Have you heard of an instance which occurred some two years ago of the gates on the Liverpool and Manchester railroad being carried off in the middle of the night?—I recollect hearing of the circumstance.

Would such a thing occur with *your* carriage, if it were to come against a turnpike gate?—It might possibly, by charging a turnpike gate with full steam, and carry it away; but a man must be mad to do it.

Do you conceive your power is sufficient to do that under ordinary circumstances?—I think not.

Have you heard of an instance of Mr. Hancock's engine striking the corner of a house?—I was in the country at the time I heard of the circumstances, but I do not know whose carriage it was; I do not think it was Mr. Hancock's.* I simply heard of a wall being driven in at Paddington. A great number of caricatures of steam carriages have certainly taken place; a great many undigested experiments have been made on the public roads, which have tended much to prejudice the public mind against the subject.

What means do you propose for preventing the establishment of other caricatures, as you call them, of your project?—I think the toll being placed on the weight of the carriage will limit them in size. The clause in the bill subjecting them to double pressure will be also another means; I think the clause limiting the size of the boiler will be the principal. Possibly, if the prohibitory tolls be taken off, and the subject be allowed to go on fairly, fair and legitimate carriages will alone be soon on the road.

In what manner do you propose to guard against the introduction of other carriages further than as the weight would prevent their running with success?—The weight of the carriage would be only one guard, the proof to which the boiler is submitted would be a second, and the limited size of the boiler would be a third. Those are as much as I can point out capable of legislation.

You were understood to state that there is no difficulty, however small the boiler, to raise the power of the engine?—However small the vessels composing the boiler, you may with vessels not exceeding an inch in diameter obtain forty-horse power, or even one hundred-horse power.

Do you suppose it would not answer for an individual to undertake to draw a train weighing twenty or thirty tons to pay a toll upon them?—In the first place, I think it would not be practicable to do it; secondly, the expense would be very considerably more than horses: for when we exceed a given relative weight the expense of steam becomes greater than that of horses.

Can you state what the limit is?—If I speak in engineer's terms, a horse power boiler should not exceed three hundred weight; if it exceeds this weight it becomes far more expensive than horses.

If you could have, without increasing the size of the boiler, a forty-horse power engine, it is perfectly evident you could carry three times forty hundred weight?—I think I am misundersrood. In regard to pressure, I have been speaking of the separate vessels composing the boiler; if one vessel will generate steam enough for a horse power, then it will require two for a two-horse power. If you require a forty-horse power, you must have forty vessels, each vessel or series representing a horse power. The boiler for producing steam sufficient for a horse power must be practically under three hundred weight.

In your engine for every horse power you

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* The carriage which performed this exploit, was Messrs. Macerone and Squire's.

would have a distinct boiler?—For every horse power there is a given number of those tubes, increasing in direct ratio as the horse power is increased; so the number of those must always be increased in that ratio.

You were understood to say you could increase the pressure on your boiler to any given extent?—Certainly. The tubes when formed together compose the boiler as a whole, every tube will bear the same pressure.

You were understood to have stated that a boiler could bear pressure to a hundred atmospheres?—I said it was capable of almost unlimited resistance.

How would you restrain any individual from making a pressure on a given tube of above one-horse power?—I hardly understand the question. If he was to double the pressure upon a tube, the power of the engine would be increased. This is a question more of force or intensity than a question of power. Series of tubes would work the engine under the power of one hundred to an inch, or at fifty; the rate would determine the power. What is gained in power may be lost in time. The actual power is represented by the quantity of steam, not by the pressure.

Your steam carriages are totally inapplicable for merchandise?—Quite so; only for passengers and quick travelling.

With how many carriages in their train?—Not more than one.

You can go, you say, at the rate of eighteen miles an hour?—Certainly it can be done, but the best practical rate is from twelve to fourteen.

How soon after the new tolls were imposed did you give up running between Gloucester and Cheltenham?—Not till they were imposed.

How soon after?—Directly.

Did you find it a profitable speculation?—The speculation belonged to Sir Charles Dance; he was the proprietor of the carriage; and the speculation was his. It appears from the accounts of expenditure and return that there must have been a considerable profit.

You considered it a profitable undertaking?—Yes. I have a letter of Sir Charles Dance's, in which he states it himself.

Can you say why Sir Charles Dance did not try running in the neighborhood of London, where there were no such tolls?—After he returned from Gloucester he became acquainted with Messrs. Maudslay and Field, the great practical engineers; they made alterations in the carriage, with a view of improving it. Experiments were made after that by Sir Charles Dance and Mr. Field, to determine the vale of these alterations; but they never ran, nor did Sir Charles intend to run till we could get the question of tolls settled; it was not the particular road on which the tolls were laid then that stopped us, but the fact that wherever we attempted to run, or contracts were made, we were met by an Act of Parliament.

Was there any instance of an act being passed except where some great improvement took place on the road, or the existing act had expired?—I cannot answer that question as to the cause directly which occasioned acts to pass; but this I can state, that on the great line of road between London and Liverpool, Liverpool and Edinburgh, which were contracted for, the turnpike tolls were laid; also between Glasgow and Edinburgh.

Are you correctly informed on that?—Yes, as to the amount of tolls, but not as to the motives.

Was it on all?—On particular trusts.

Are you informed under what circumstances those acts were obtained?—I am not informed under what circumstances.—I firmly believe they were misinformed as to the subject. There was no intention on the part of the trustees to put on tolls in the way of prohibition, but as a fancied just protection. In my petition in 1831 I stated this. I prayed that inquiries might be made, in order that just and equitable tolls might be placed on steam-carriages.

Then it appears it was only on certain roads that those tolls were laid?—On certain roads which occurred along the great roads, here and there, but so sufficient that if we take the roads from Liverpool to Edinburgh, taking all, "they would amount to 1s. for every mile run over, taking the whole distance;" this was stated in evidence by the contractor. If the tolls were laid on at the rest of the gates on the line in the same proportion, they would have amounted to 1*l*.

Are you not aware that you might have run during the periods, if the acts were still to exist; you might have run without any fear of an increase of toll?—Yes; but to what purpose? My object was not to

run for profit as a coach proprietor; its public introduction was the work of great capitalists. I had not capital enough to introduce a subject of such importance; and the capitalists who were disposed to establish it, and had licences, were not disposed to go on with it when that spirit was shown on the part of the Legislature.

You had got the patent. Your object was not to run the carriages, but to sell the right of running carriages to other persons. You were not the person who gave it up, but they gave it up?—Yes.

You found no person who would undertake to run with your patent, and in that way you were injured?—Capitalists undertook to run to a certain extent; contracts were made with great capitalists, but those did not withdraw from their contracts until the bill for their repeal was lost in the Lords. If this bill passes I could to-morrow find capitalists.

How is it that no capitalist have been found to run on the road near London, where no such toll is imposed, and where two or three carriages are running?—I conceive if carriages are now running it is on the faith of tolls being taken off, or they may be experimental carriages; but the reason why capitalists will not run carriages in the neighborhood of town, is the fear of the spirit in which those acts have been passed.

It appears capitalists have been found to run other carriages. Hancock runs his own coaches?—I do not think any capitalist would be disposed to run short stages; the great advantage is in long distances; the stopping on short stages would increase the expense very much in the consumption of coke, and other expenses,

Do you apprehend Hancock's is an unprofitable speculation?—I have not a conception whether it is or not.

The question is, how do you conceive it arises that no person has bought of you the right to start a coach near London, when other coaches have been running and plying for hire near London?—In 1831, when acts passed, I shut up my establishment, and I retired from the subject, at that time feeling injury had been done to me, and thinking I was unfairly treated; when the repeal did not pass I sold all my materials for manufacturing, and gave up my manufactory. Capitalists would not apply to me after that, and I have not applied to them. I have been engaged in other pursuits lately, waiting in the full expectation that the question would be soon settled so as to enable me again to apply myself to the subject. I may be allowed to remark that the instant this bill passed the Commons, and it was expected it would pass the Lords, large capitalists have applied to a considerable extent, to whom I have granted licences.

MR. WALTER HANCOCK.

Has now three steam-carriages running between Paddington and the Bank. The engines to each carriage are of two four-horse power; perform about twelve miles an hour, and consume from a bushel and a half to two bushels of coke an hour.

Have you ever been in the back part of your coach when it was travelling?—Frequently.

Have you seen whether any sparks came out of the bottom?—In the former part of my experience I found that a great objection, and I in consequence formed the fire-place so as to prevent any coming out, and now you may travel hundreds of miles in my carriage, and not see a spark come out of it. It was a matter of difficulty to get over the objection, but I surmounted it by excluding the possibility of any spark being seen.

You have stated that no sparks came out at the bottom; does any smoke come out at the top?—No. We have destroyed both the steam and smoke. Occasionally when the gas is not so clear as it generally is there has been a little smoke seen.

Do you use coke of any particular sort?—The common gas coke.

How do you let off your surplus steam?—I have two safety-valves. It is not heard; there is no noise of steam escaping.

How do you avoid that?—There is an apparatus in the carriage that prevents it, so as to deaden the sound.

The noise is there, but deadened?—The force is there, but deadened before it flows out in the common atmosphere; but this is not allowed; it is gradully spent.

Is that by taking it into a larger chamber?—I think there are about twenty or thirty of those chambers the steam passes through.

Do any sparks fly out at the top of the

chimney?—I never discovered any; there have been great improvements of late.

What are your great improvements?—They throw the steam in a particular direction so as to come into contact with the fire, after it has passed the chamber; the steam not passing out, as in common locomotive engines, has not the power of drawing up the ashes as in the common engines.

Have you had any accident with your carriage?—I never had any accident myself; there was one accident occured, but there was no personal injury by it; I never had an accident occur with my carriages upon the road from the boiler.

Did any accident occur with any carriage?—Yes.

When was that?—I think three or four years ago.

None has occurred since that?—No.

Was that when the carriage was in motion?—It was on the first trial of a new carriage called the "Enterprise," a carriage now running for hire on the City-road. The man who was attending the machinery did not thoroughly understand the nature of the machinery, and he got one of his safety-valves at wotk. He had one valve tied down. We had what we call a blowing-machine to produce a greater heat; he had immense heat. I have no doubt he had the boiler filled full of water. The engines going very fast increased the pressure to as nearly as possible 1,400 lbs. upon the inch before it rent itself. The engineer, on his coming up the yard, says, "For God's sake release that valve." In the act of his turning about the rent took place; he was so paralysed he never could be restored.

How did it produce this effect; was he wounded?—No; not touched in the least.

Where was this?—Down at Stratford, at the manufactory.

You mean that the valve was confined?—Yes.

Was any one hurt upon that occasion?—No.

What became of the man?—The doctor could not bleed him, and he died in consequence of fright.

Have your boilers ever burst?—I have had rents in the boilers I suppose a hundred times.

Have any bad consequences ensued to the passengers?—No; quite the contrary. On the road we had been running very successfully all the day. We were taking in water. One of the chambers had given way, and when we were about to start again there was not half the pressure. We examined into the cause, and found that the bottom part of one of our chambers had rent about an inch and a half. We had just steam enough to get the carriage to the yard; it produced no noise whatever.

There were no inconvenient consequences resulted?—No; only the delay.

How long have you been at work on steam-carriages for the road?—I think the last nine years.

Do you know how many miles your carriages have travelled?—I should be quite within compass if I said 30,000 to 40,000 miles.

How soon can you stop?—I have been abliged to stop the machine within two to four feet. A boy fell down before the carriage, and it was not three feet when I stopped it.

Can you stop at that distance?—I can stop within two feet going up hill.

What is your usual pace of travelling?—I generally go eight miles an hour. In going to Birmingham we averaged sixteen and seventeen miles an hour at times for hours.

In how short a space can you stop on a good hard road?—That will depend upon the speed we are going.

If you were travelling eight miles an hour?—Within ten feet; the man puts his hand upon a lever to turn the steam off, and gives a signal to put on the break.

What is your charge per mile?—It is sixpence from Paddington to the Bank, which is about five miles; rather more than one penny a mile.

What is the charge of the omnibuses?—The same.

What is the weight of your machine and carriage altogether?—I should think about three tons and a half to four tons.

What tolls do you pay?—On the Paddington-road 4d., that is, on the City-road.

What is the rate on other carriages?—An omnibus pays 2d. for carrying the same number of passengers.

The danger of a boiler bursting is in proportion to its size, is it not—on the same principle that a cannon requires to be made

stronger than a smaller gun?—That will depend upon the size and thickness. In my boiler all the braces would require to be stronger, and the outer plates stronger.—These boilers, I have no doubt, would bear a pressure of five to six hundred pounds the inch.

You stated that you make the same charge that the omnibuses do; could you afford it rather cheaper?—The money I have lost in experiments has been from 10,000*l*. to 12,000*l*, and I have sacrificed nine to ten years full of my time. I ought to get as much as I can by the fare, but not to make it unreasonable.

Do you find your carriage fills?—Very well indeed.

Does it fill with persons who go in it onca from curiosity, or persons who regularly go by it?—We have regular customers.

Do you perform the space in less time?—Yes; we aveage from the city to Paddington and back froman hour and a quarter to an hour and twenty minutes.

What is the distance?—Nearly ten miles.

What do the omnibuses take?—Before I came upon the road they were two hours and twenty minutes; but now they do it in nearly the same time that I do, being driven to it by the competition through steam. It has produced a public good in that respect against the will of the drivers.

Do the omnibuses contrive to go as you do by an increase of their positive speed, or by abstaining from stopping?—Both.

What is the average pace you go?—About nine or ten miles an hour; the omnibuses go from eight to nine miles an hour.

How many horse power have you on your engine?—I think it is between eight and ten on the "Enterprize;" the "Era," I think, is about eight.

You reckon that, as equivalent to having how many horses attached to your carriage?—We reckon both of those to carry passengers equal to an omnibus with two horses, but I take into consideration the weight of the carriage and the weight of the horses. There is a mistake in the Bill. I think now that we shall pay double the tolls that other carriages do. We are not allowed the weight of the horses and the weight of the carriage. We suppose a horse draws one ton, and that is measured for a steam-coach; then there is no consideration of the weight of the horses and the vehicle drawn by the horses.

You think that even if this Bill passes in its present form, steam-carriages will be at a disadvantage compared with other carriages?—Yes. We ought to have two tons and a half instead of a ton allowed to one-horse power, to include horse and cart and load, the weight of which will amount to two tons and a half.

You calculate a horse power in a steam-carriage to be equivalent to three hundred weight?—Yes.

You call the draught by a locomotive engine of one-horse power equivalent to three hundred weight: consequently, before you could draw a ton, you must have three-horse power to do the same thing?—The "Era" carriage drew the "Infant." The "Infant" and the "Era" are about the same weight, about three tons and a half in weight. The average speed of the "Era" is about ten miles an hour, and with an engine behind it went about the rate of seven or seven and a half an hour. I consumed no more coke in the distance in those seven miles. According to that our carriages will draw about the same weight with the same steam and water but we lose about two miles and a half per hour in speed. A horse power we consider equal to lifting 250 lbs. over a pulley, and that is very different from drawing; a horse power is considered as equal in drawing a ton. If we were to run one of those carriages the day through it would do as much as thirty horses.

Your carriage does work equal to thirty horses?—Yes; if they were to keep on the whole day. The work I am doing now is about equal to ten horses. Ten horses would be employed to do the same work. Five journeys from Paddington to London would take ten horses. This is about the same.

Do you go at the rate of ten miles an hour through the narrow streets?—No, certainly not; we pass through the streets very gently. I have been through the streets in the city hundreds of times, and persons would hardly know we were passing.

Do you concur in the opinion that there is much danger arising from a large boiler?—So much depends upon the principle on which it is made. I have no objection to a boiler of 100-horse power on my principle; there is no difficulty in making a boiler of the size of this room upon that principle; it can be extended or increased by increasing the number of chambers.

That is a number of small boilers joined together?—Yes. I can increase the size of the boiler by increasing the number.

The question refers to one large boiler in its own capacity?—Under any circumstances I rather feel timid in a steam-vessel with a large capacity. When we come to increase the size of the surface if has a greater effect to burst if metal is weak.

What is the largest boiler which you think could with safety be used on the public high roads?—A cylinder of twenty inches diameter, if the materials are well selected, and with the proper proportion of thickness, produces as great a safety in proportion as any other vessel. The cylindrical form is strong, but it is no stronger than any thing that is square, if the parts of the vessel are supported with sufficient materials. It all depends upon the thickness. The strain of a cylinder is the same as if it were of a given length, and was pulled at each end. If the thickness of the metal is not sufficient to sustain the pressure inside it will be sure to rent, and a cylinder of twelve inches may be made equally dangerous, if it is nat strong, as one of twenty.

Would the danger from blowing up a cylinder of ten inches be equal to that of blowing up a larger cylinder?—Certainly. A cylinder of ten inches, if it communicated to any other part of the boiler so as to make a continuous explosion, it would be nothing more than a discharge from the engine with greater report. If one of the bolts in my boiler was to break I should have twenty-five safety valves; there will be fifty apertures for the steam to escape, and there will be nothing like a report. All the seams or joints will be open, and the steam will escape, and lose its force.

It is in evidence that for public safety the extreme size of a boiler ought not to exceed eight or nine inches in circumference, and that it is essential to keep within that size. Do you concur in that opinion?—I think that a vessel of three times the size of it is capable of bearing the power. There is no necessity for limiting the size if the vessels are sufficiently strong.

The object of that observation was, that if it was not sufficiently strong, and did explode, no damage would arise; that is your opinion?—If it were twenty-four inches, and were to burst, I do not think that there would be any danger if no longer than three feet. I am making a carriage where the cylinder will be sixteen inches in diameter, and vessels containing a much larger portion of steam than a cylinder for a ten inch boiler.

What is the object of that carriage?—For passengers.

Do you conceive that this method of travelling upon the high roads can ever be adapted to the conveyance of heavy goods?—Yes; I think passengers may be taken in the steam carriage itself, and goods behind.

The question respects heavy goods?—Yes. Not the heaviest goods; perhaps they would not be so profitable; but light Birmingham goods, and things of that description.

It would not be likely to supersede the heavy waggons?—I think it is very probable it might; in fact I consider it a medium superior to horse conveyance, and inferior to the railroad in regard to speed, but likely to prove much more profitable.

Are you acquainted with Mr. Gurney's plan?—Yes. We differ entirely.

You imagine yours to be preferable?—I think the fair answer to that would be the great expenditure Mr. Gurney has made to bring it to bear; and that mine have been brought into use at a much less expenditure, say one-fourth, and all at my own expense. Mr. Gurney had the capital of a number of persons.

You consider the advantage of yours to be principally in economy?—I consider that my boiler stands the work much better than his. I had some difficulty in getting the proportions of strength of iron-work to the machinery.

Your other machinery is pretty nearly the same?—The arrangement is different. The whole is on springs in mine, and upright; and his horizontal, and a crank axletree; mine is straight.

You have both adopted a mode of getting rid of the draught through the chimney?—I have a blowing machine, so that I can increase the draught at pleasure.

Do you not use the steam for that purpose?—No; it makes too much noise; it would frighten the horses.

Does Mr. Gerney's carriage make any noise?—It made a hissing noise when I saw it, just before it went down to Cheltenham and Gloucester, from the escape of the steam into the chimney. There was a very good draught, but it would make too much

noise for us. It is the same as is adopted on the railroad. If I adopt that plan I should frighten the horses off a common road.

You thing that his carriage would frighten a horse off the road?—I am quite confident that the letting off the steam without its being quieted would frighten horses If we could use the steam in the chimney without producing any nuisance we should save a considerable expense.

You would not be afraid of any competition from Mr. Gurney running against you?—I should not be afraid of competition.

Do you think any other carriages which have been running can be put into competition with yours?—The thing stands entirely upon its own merits, and the best will be appreciated.

MR. JOSHUA FIELD CALLED IN AND EXAMINED.

Have you turned your attention to the construction of locomotive-carriages to run on public highways?—I have been employed in making experiments on this subject by some gentlemen as a matter of business.

Is there an engine goes by the name of Field and Maudslay's?—The machine in question was made for some gentlemen; it was not our property.

Will you state what was its weight, and how many persons it was constructed to carry?—It weighed, with water and coals, six tons; it was merely a drag to draw another carriage.

How many carriages would it draw; one or more?—It was generally applied to draw one ordinary omnibus; but it has drawn two and three.

Along what sort of road; a good hard road?—The roads about London.

Gravel roads?—Yes, or Macadamised.

Is it at work now?—No.

Was it meant to work?—It was built as an experiment.

To try what?—To try what might be done on the roads.

Did it succeed?—Yes.

What was the object you wanted to attain?—The object of the party was to give the subject a fair trial.

Did it ever run any length of time?—It performed many journeys last summer.

On the roads immediately about London?—Yes; it went various times to Reading.

Drawing carriages after it?—On those occasions it drew one carriage.

What rate did it travel at?—From twelve, fourteen, fifteen, sixteen and even at the rate of eighteen miles an hour.

What was the pressure; how many horse power?—It is difficult to estimate the power of such a machine by horse-power without the resistance being known.

What other means of estimating the power of a steam-engine have you?—Fixed steam-engines are easily estimated by horse power, but the power of a locomotive engine varies with every rate at which it runs.

In proportion as you increase the rate you would lose the power; what you gained in velocity you would lose in power?—Not exactly so; it would take more power to drive a carriage sixteen miles an hour than it would twelve; at the highest velocity it would exert the greatest power.

Have the goodness to give the Committee some way of estimating the power of an engine in any way you think you can explain it most satisfactorily?—The ordinary mode of estimating the power of a steam-engine is to ascertain the effective pressure of the steam on the piston; the area of the piston, and the rate at which it travels, reducing this to pounds weight, moving one foot per minute, gives the power of the engine moving at this rate; then dividing this sum by 33,000lbs., which is supposed to be the weight one horse can raise one foot in a minute, gives the number of horses' power.

Apply that to your engine, if that is your mode of estimating the force of an engine; apply that, and tell us what the power of your engine was in that carriage?—That would be extremely difficult to do in this case, some of the data not being known; but I think the object of the inquiry would be answered by stating that the cylinders were ten inches in diameter, the steam from 50 to 100lbs. on the square inch, and sixteen inches stroke; such an engine may be estimated at about twenty horses-power.

You had a number of cylinders?—Two.

What length of time did you complete your journey to Reading?—Three hours and ten minutes average both ways.

How often do you go there?—It went five or six times down that road, some journeys to Slough, and once to Marlborough.

Did you go with it?—Once only to Slough, and once to Marlborough.

Did you observe that your carriage frightened the horses on the roads?—Occasionally horses would shy.

Have you seen any serious accidents?—No.

Did the horses shy more or less than at meeting a stage-coach? —More so, from the novelty of the thing.

Would a noise accompany your carriage? —A little.

From the carriage or the steam?—More from the hissing of the steam.

Were there any sparks; none were visible by day-light?—No.

Have you ever travelled by night?—On one occasion.

Were there any sparks?—A considerable number.

Have you taken any precautions or tried any thing to prevent the emission of sparks? —We had at one time a wire-gauze over the top.

Did it answer?—As it rather impaired the draft it was taken off, and was not on when we travelled by night.

Have you seen that wire-gauze applied to other locomotive-engines on railroads?—Yes.

Travelling at the same speed?—Yes; at all speeds on the railroads they have gauze.

Have you seen them travelling at the same speed, fourteen miles an hour, or whatever it is, with the wire-gauze on the top of the chimney?—Yes; and at much higher velocities.

But at that velocity did not sparks fly out, and would they not at a more great velocity than at a moderate one?—I never observed any.

When they travelled at that velocity have you observed the sparks fly out, notwithstanding the gauze?—I have only travelled by day-time.

Did you use coal or coke?—Coal, and that accounts for the great number of sparks.

Is yours a large chamber—the boiler?—It was divided into a great number of small tubes.

Of what size?—The largest was two inches in diameter.

Were they cylindrical?—Yes.

And so small as that?—The largest part exposed to the pressure of the steam was only two inches in diameter.

How much coal did you consume in an hour, do you know?—I cannot speak very accurately to this, as those experiments were made more to ascertain the effect than the quantities of coal consumed.

Did you observe what effect it had on the road; did it make ruts?—Not at all.

What was the width of the tire of your wheels?—Three inches and a half.

They did not sink into the road?—No, not at all.

Were the roads wet or dry?—These experiments were chiefly made in the summer, but the carriage has run when the roads were soft and muddy.

Then it was very dry weather?—Yes, for the most part.

Have you ever travelled by any of the steam-carriages that go by the name of Hancock's?—Once.

When was that; lately?—It was about eighteen months ago.

Do you know his constructions?—Yes, generally.

Do you consider it safe?—I think it is.

Where was it you travelled; on the New-road?—Yes.

Did you observe that the horses were frightened at it?—No.

There was no starting?—No.

Did the horses pay more attention to it than they did to the Paddington omnibuses or the Paddington stages?—I did not observe that they did.

You conceive the mechanism is such as to secure safety to the individuals who travelled by it?—Yes.

Did it seem to move and turn very readily? —Very easily.

You had no accident with it while you were upon it?—No.

Have you ever seen Mr. Gurney's steam-carriage?—I never saw one of Gurney's under way, except an old one belonging to Sir Charles Dance, quite altered as it regards the boiler.

But not Gurney's most improved and last-made carriage; his best carriage?—No.

Do you know the nature of the construction of his carriage?—Yes, as it was five years ago.

Do you consider his safe?—I did not consider the large flat-sided chamber safe.

But not latterly; it has a round cylindrical tube?—I do not know.

Do you know Colonel Macerone's?—No.

You do not know any thing about it?—No.

Are there any others you know, whose mechanism you are acquainted with?—I have seen Mr. Ogle's, but not at work.

Do you know the nature of his plan?—Yes.

Do you consider that safe?—Yes; I think the boiler safe.

Safe with respect to explosion?—Yes.

You have never seen it under way, therefore you do not know its effect?—No.

The only one you have seen tried is the one youl built, and Hancock's?—The only steam-carriages I have seen moving are that we built ourselves, and an old one of Sir Charles Dance's partly composed of one of Gurney's original carriages, Mr. Hancock's, and one made by one of my partners, which was a railroad-engine, put on the road with plain wheels for experiment.

Have you seen that under way?—Yes.

Do you consider the mechanism of that such as to be safe for passengers?—Yes; as safe as the ordinary railroad-engine.

Did you find the horses start at that?—A little; not much.

More than at Hancock's?—I think so, as the noise is greater from the escape-steam.

Did Hancock's make a noise?—Not much.

Is it the rattling of the carriage, or the whizzing of the steam?—I think about half each.

They do not neutralize each other?—No.

You have never seen Gurney's?—No.

Did horses start at Sir Charles Dance's?—A little occasionally.

More than at Hancock's?—I cannot say, but should think them much the same in that respect.

Do you know the mechanism of that of Dance's?—Yes.

Do you consider that safe?—It is just the same as one we made as it regards the boiler, and the mechanism very similar.

You consider yours safe of course?—It is quite safe from explosion.

But is it safe in other respects; is it safe to travel along the road with?—Yes.

Not only for the persons travelling, but for the persons it meets?—All carriages going at great velocities make more noise, and are consequently more likely to frighten horses.

Do you think they are as safe to meet as a mail-coach?—Until horses are more accustomed to them.

You think there might be considerable danger at times from horses taking fright?—Yes; from this as well as from any other cause.

How would the effect of them be at night, as far as you can judge?—At night the flame and the sparks are an objection; improvements may obviate this.

They are visible?—Yes, at night, when coal is used; less if coke is used, as is the case with Hancock's and some others.

You never saw it?—No; but from the manner in which Hancock's flame is divided and the heat absorbed, I should think it likely that less flame would be visible.

Do you think his plan, as far as you can judge of it, would secure you from sparks falling in the road?—I think it might be lessened in every construction by a gauze at the top.

Are you of opinion that gauze at the top is an effectual remedy against the emission of sparks from locomotive engines?—Not the smallest sparks perhaps, but the largest, certainly.

That would apply in the same way to Mr. Hancock's?—Yes, just the same.

Could you make a gauze sufficiently close to keep a draught, and prevent the smallest sparks escaping?—That object can be attained only by increasing the gauze head to such extent that the sum of all the openings in the wire shall be equal to the area necessary for the draft.

But do you think that object has been attained?—I do not know that it has.

Part of Hancock's plan is the one adopted on railroads also; to turn the steam into the chimney to create a draught?—I rather think he turns the steam into the ash-pit, and so lets it pass with the air through the fire.

And then it goes up the chimney?—I am not fully acquainted with the construction of it.

You say you think danger would attend the use of steam carriages till the horses were accustomed to it; at the same time you say, when you travelled by Hancock's along the New-road, there was no appearance of the horses being frightened?—No, there was not; and I think the noise and the smoke might be very much abated if it became a general thing. In the experiments I have been mostly engaged in, that has not been so much an object as to produce the effect.

What legislative provisions would you

suggest to enforce a due attention to that object?—I am not prepared to suggest any.

What would be the mode of doing it that would occur to you to induce engineers to turn their attention to that point?—Any thing that would induce or oblige them to lessen the noise, flame, and sparks.

With regard to the smell, is there not a great effluvia arising from Hancock's carriage?—I have understood there is: I did not perceive it.

When you were travelling along by it you did not perceive it?—No.

What is it from?—It is from the steam passing through the fire, and the products of the coke.

Have you any opinion of the size that it would be desirable that the boilers to run along high roads should be allowed?—I think it difficult to prescribe a rule of that kind.

Do you think it possible in any case danger could arise from a boiler that is cylindrical, of which the diameter was not more than ten inches, supposing it were to burst?—If it exploded, even that diameter would produce mischief to those who were near it.

The notion is to divide the boilers into chambers, and the chambers should not exceed ten inches in diameter; do you think danger would arise from the bursting of that?—I should be afraid to stand near one when it exploded.

Can you state that size of the chamber which, if it was to explode, would not be dangerous?—I should think any chamber exploding beyond three inches in diameter would be dangerous.

Below that you think no serious harm could arise?—No; it would rend, and let the steam out.

Do you find it very difficult to get men capable of managing locomotive engines on roads or on railroads?—There has been so little experience hitherto that we have always trusted the carriage to one steersman, who is very expert, and have never had any accident. He is a man formerly in the employ of Sir Charles Dance, and who came to us from him. I have travelled some hundred miles with carriages which he has steered, and he has in no instance met with an accident.

What carriages were those?—It was the old carriage of Sir Charles Dance's and that made by us.

You have been many hundred miles on that?—Yes; and that we made last summer.

As you probably employ a great number of men of that class, do you think there are many men capable of conducting a steam carriage?—I think every coachman would be able to steer well with practice.

You mean a good coachman could conduct a steam carriage?—Yes.

And your engineers, you must have an engineer with your carriage besides?—Yes.

Is that a class of men you can easily find? —Yes.

And capable of doing it?—Yes, very easily.

Is there any such nicety in the work that if they were to get drunk, or take too much, they would be liable to accident?—Not more so than on a railway, or a locomotive engine, or a steamboat.

But on a railway the locomotive-engine could not have the opportunity of stopping at different public-houses?—Certainly not.

Therefore there would not be the same probability of a man getting drunk?—The steersman may be considered exactly the same as a stage-coachman in that respect, all depends upon his care.

You think there would be no more risk from a drunken engineer than from a drunken coachman?—They are much the same.

There would be no more danger arising from the misconduct in that way of an engineer than from that of a coachman?—No; I think not.

And that the engine is not a more dangerous vehicle to be conducted?—No.

Within what space could you stop your engine that you went to Reading in, going at the rate of twelve or thirteen miles an hour?—In about the space a coach would stop.

Three or four yards?—Yes.

It was in Sir Charles Dance's you travelled so far, and is that as easily stopped?—I spoke of that, and the carriage we made.

And would it turn as easily?—Yes.

Would it turn as easily as a stage-coach to get out of the way?—Quite so.

Could yours?—Quite so.

And does Hancock's?—It is quite as manageable as a stage-coach.

Do you think it desirable on high roads to have drags for other carriages, or to carry the passengers on the engine itself?—I should think passengers would be more comfortable in a separate carriage.

Which would be the safest for the public?—A separate carriage.

Do you not think that the length of the carriage on the road would be a serious inconvenience, and be attended with considerable danger?—It is not longer than a coach and four horses altogether, with the drag.

Would you think it dangerous that a carriage of the length of one of the great timber-waggons that you see should travel on the high-road at a great speed?—Extending the length beyond certain limits would increase the danger.

You think it would be desirable that that length should not be extended?—The shorter it is the better.

Do you think it would be desirable to have any mode of testing the boiler of steam carriages?—I think they should be tested.

You, of course, use some mode of testing them before you send them out of your factory?—Yes.

Would there be any means of enforcing such a test to prevent neglect on the part of engineers, to prevent mere adventurers?—I think it might be done.

How could it be done entirely?—By forcing them with water. It would require some officer to examine and to see them tested.

Is there any difficulty in the use of the instrument you use to test them to require a scientific person to apply it?—Not at all.

Any individual might do so?—Every carriage has a hand-pump, which is an instrument by which the boiler might any time be proved. The pump which fills the boiler before starting, or in case of the water being short, that pump is the most appropriate instrument for proving the boiler; so that if the safety valve was weighted to double the extent at which it was determined the boiler should work, it might be proved at any time.

Might it be proved, suppose the Legislature required that the boilers should be tested before a magistrate, would he be capable of seeing the test was correctly applied, or does it require a scientific person to do it?—It requires a scientific person, or it might be evaded.

Is there any means to be adopted by which such a test should not be evaded?—I can suggest no other than that of a qualified person to superintend it.

What do you think might be the test of a boiler; how many times the pressure that is intended?—I should say double.

You think that sufficient?—Yes.

What test do you generally adopt in your boilers?—Our boiler was so strong that it would have borne five times the pressure we worked it at, so that we were free from any apprehension of explosion.

But with boilers generally you know to what pressure it is intended to subject them. and you subject them to a test?—Boilers having to sustain great pressure are tested double.

When you make high pressure engines you must test them?—Yes; to double the pressure intended to be used.

You think double the pressure required would be sufficient?—Yes, I think it would.

If there were a provision that it should not be lawful to use any vessel to propel a carriage any part of the transverse section of which should not exceed ten inches circular or cylindrical—you think that is too large an allowance—do you think that would not secure safety to the passengers?—It would certainly be dangerous to passengers if it should explode.

But if it is properly tested there is a security against explosion?—It would be safe if it were made sufficiently strong and tested.

If it were not made sufficiently strong it would not stand the test?—No.

If it does stand the test, you think there would be no danger in that?—No; making allowance for decay.

You say you knew the principle of Gurney's mechanism, and you thought it safe? Yes.

Was not that the principle of his chambers—of his boilers?—The cylindrical vessels were considered safe, but the square flat vessels which he used at one time I did not consider safe.

But the cylindrical were his patent?—I do not know what his patent is.

Though a vessel may have been tested and pronounced to be safe, yet is it not possible that it may be used for too great a time, and that danger may arise from that circumstance?—Certainly it is.

Can there be any limit fairly put as to time without doing injustice?—I think no limit could be set as to time, for a boiler may be as much injured in one day, and its strength impaired by accident, as in ordinary wear it would be in twelve months.

The test is only a guarantee of safety at the time it is applied?—Exactly so.

These chambers may be perfectly safe at

one moment, without any appearance of danger, and may burst the next?—It is quite possible.

I do not know if you are of opinion that a small chamber, though it should burst, would not produce any disastrous consequences?—I am perfectly aware of that. Indeed the boiler used in the experiment in which I have been engaged is one of which Sir Charles Dance, in conjunction with myself, has a patent, the principal feature of which is, that no part of the boiler exposed to the pressure of the steam should exceed three inches in diameter, and therefore may be considered perfectly free from danger from explosion under any circumstances with any degree of wear, so as to remove entirely the apprehension of any danger to the passengers from the explosion of the boilers.

MR. BENJAMIN W. HORNE, COACH PROPRIETOR.

There is a great hostility among coach proprietors to steam-carriages, is there not? —Not at all. If we should prefer either, we should prefer those on the high road to those on the railroad, for the competition is greater. I speak with a degree of honesty.

What weight do you require a horse should draw in a stage-coach, a coach fairly loaded? —They so much vary; from two to three tons.

In your own establishment what do you calculate the weight of the fast coaches when loaded?—About two tons; not exceeding.

You have some coaches faster than others? The difference of about three miles an hour.

The fastest go about ten miles an hour? —Eleven.

What is the full weight of a loaded coach going at the rate of eleven miles an hour?— Not exceeding two tons.

What is the full weight of a loaded coach that does not go more than eight miles an hour?—They are short coaches that go merely to Dorking, Sundridge, and Egham; they do not go at the rapid speed, as others do.

Have you any that go eight miles?—All distances.

Have you any eight mile an hour coaches? —Yes, a Dorking coach that goes eight or nine miles an hour.

What is the weight of that loaded coach more than the others?—It is the same as one that travels from 70 to 100 miles; it is the day and night.

The day coach does not exceed two tons; About that.

What is the weight of a night coach?—It might be perhaps occasionally according to the season of the year; if it is a mercantile town it varies; it is occasionally half a ton more; two tons and a half.

What rate would that coach go?—Nearly ten miles an hour.

Do you horse any vans?—No.

Do you run to Norwich?—Yes.

Does that come up loaded with turkeys at Christmas time?—Yes.

What is the weight of it?—When we have turkeys there is hardly any passengers; scarcely any difference; it might weigh three tons; hardly that.

You require about five hundred weight as the load of each horse?—About that.

How many miles do you reckon that a horse ought to go at the rate of eleven miles an hour, drawing five hundred weight, per diem.—About eight miles.

Does the same horse do eight miles seven days in the week?—If it exceeds ten there is another horse kept, which brings it down fifty-six, and he will go fifty-six miles a weeks. We calculate a horse a mile; that brings eight miles to eight horses, or fifty-six miles a week. Very few coaches will average more.

You think you should be able to compete with steam-carriages; do you think you should beat them?—I fancy so. I only hope that steam-carriages will be on the high road instead of being on railroads; there is every probability of our coaches doing very well if they draw about half the weight.— With a tramroad we could maintain about twelve miles an hour very easily; on a tramroad in narrow streets, where waggons or gigs are going, you will find the gig will over-run the horse.

Is there any difference in the tolls, on the roads with which you are acquainted, between steam-carriages and stage-coaches on any of the roads?—As far as the practical part of steam-carriages go, they do not have to encounter much with turnpikes; there are very few about London; the Metropolitan Act has done away with them.

There is great variation in your tolls, is there not?—Wonderful.

What are the highest tolls on the road you go?—The highest, taking the average per mile, will differ from 9s. to 17s. 6d. on different roads.

Per mile ?—Yes; per mile per month; the difference will be on the whole of the month.

Where is the highest ?—On the Birmingham line of road.

Are you connected with any coaches running between Glasgow ?—We do not extend beyond Leeds or Manchester.

You run as far as Holyhead ?—As far as Shrewsbury.

You pay a post-horse duty besides the tolls ?—We pay a stage-coach duty.

Is it on the horses or the coach ?—The coach.

Is there any duty on the steam-coach ?—I am very sorry to say there is but little paid there; I think the competition is unequal.

What is the amount of duty on the coach ? —It is according to the number of passengers we take out licence for; most are rated at two-pence halfpenny per single mile, which is five-pence per day; the number of passengers we are allowed to carry in each mile are four inside and eight out, in winter time; if four insides and eleven outsides in summer time, we pay six-pence. Steam vessels do not pay, nor do steam-carriages pay any thing to speak of. The steam-carriages do on the railroad pay a trifling duty to government, according to the numbers carried; if the machine is empty they do not pay; we pay, passengers or no passengers. We have a petition before the Treasury for reducing the price of freight between Dover and Calais and Boulogne, by the packets, as coaches going to Dover and Margate are obliged to pay a duty, which we cannot afford in consequence of the low price by steam, which does not pay duty.

You run the coaches ?—It is difficult to reduce the number of coaches; the loading is extremely uncertain; we are obliged to keep the same number of coaches; we cannot reduce the number of coaches in consequence.

MR. GEORGE STEPHENSON, C. E.

Have you turned your attention at all to locomotive carriages on public roads ?—Of course I have thought a great deal about them, having been concerned in them twenty years.

What is your opinion of them ?—I think they will never be made to do any good on a common road; I do not see the slightest possibility of it.

From what cause ?—The friction is so much greater on a common road than on a railroad, and we find we cannot with engines beat horses used on railways so very much at slow speed, as to economy. One reason why an engine competes at a much less advantage on a common road with horse power, than on a railway, may be thus stated ? a horse consumes no more power in maintaining his own motion in drawing a load on a common road than on a railway; whereas from the great weight of an enigne, and the resistance being increased tenfold, the whole of its power is consumed in upholding its own motion.

The friction on a common road is, taking an average number, ten times what it is on a railway ?—Yes; a horse will on a railway take ten times as much as on a oommon road. That being the case, the locomotive engine that is to go at this power, is travelling on a smooth surface on the railway, but the same engine using the common road is on a very different surface. The friction is increased so very much, that it has enough to do to propel its own weight, without any thing else; therefore the great advantage in getting the power generated is so much less on the railway than it is on the common road, that this alone makes a great differance.

You think, taking a given weight, say two tons, it would require ten times the power to propel it along a common road than on a railroad ?—Yes, it would.

If you had to move two tons on a railway by a locomotive engine, what power should you find it necessary to apply to make it go at the speed of fourteen miles an hour; how many horse power ?—It requires time to go into that. I will prepare that table. A horse will take ten tons, besides the weight of the carriages, at three miles an hour on a railway, and I think one ton at the same velocity on a common road. I could not tell off hand as to the exact proportions. It will require one horse power on a railway, and ten horse power on a common road.

You are well acquainted with the construction of these locomotive carriages ?—I think I am; I think I have a right to say I am. I do not think there is a possibility of keeping the engine in order for any length of time from the jolting of the engine. I do not care what springs they put on.

Have you seen Mr. Hancock's carriage running ?—No; I have been at Mr. Hancock's place, and saw his arrangements. I

thought there was a great deal of ingenuity about it, but I told him in my opinion there was not the slightest probability of making them pay. There is no doubt of their making them go on a road, but not to make them pay, for I do not think any experienced engineer would be concerned in them. Many ingenious gentlemen have turned their attention to it, but if they had had much experience in keeping steam engines in order they wouid not have gone into it at all. The last engine made of Mr. Hancock's construction was made by Maudslay & Co., and they are most excellent engine builders; it mnst be well done if they did it. I do not care how well they are done; I do not see the slightest probability of their being made to answer.

Do you suppose that Mr. Hancock's engine, if it had been running twelve months would have been running at a loss?—Yes. If I saw his books I engage to say he must have been running at a loss.

You think there is not much danger to be feared if they can be run with advantage—if they prevailed?—As to daager that may be prevented.

There is no danger of their becoming common?—No; I do not think there is any probability; there will if full power is given to every one to use them.

If all the tolls that were laid on to stop them were taken off, you still think they would not run at an advantage?—I do.

You have said that there was a probability of obviating the dangers; state what you concieve the dangers to be?—Why, I think the most likely part of the machine to become dangerous is the boiler—the bursting of the boiler; they always endeaver to make them as light as they possibly can, and to carry as little weight as possible; they construct the boiler to carry very little water; and even if the boiler is made very strong, on account of the small quantity of water being carried, when the steam is generated that soon gets dry, if there is little water it must boil away, and there are accidents that will happen to cause them to stop. If the water gets boiled down to allow the pipes to become red-hot, hydrogen gas is generated, and explosion takes place. Explosions have taken place witht hese boilers; no satisfactory reason has been given how it occurred, but it has done so. I imagine that there must be a decomposition of the steam; that when the iron becomes red-hot, the oxygen of the steam will seize the iron, and of course the hydrogen is set at liberty, it is separated from the oxygen; then, if the plate is heated to a certain degree, it will take fire and explode. In the locomotive engines on the common railroad we carry as much water as will take us thirty miles.

On the railway?—Yes; my former observation is as to a common road; I am stating the difference between that and the railway. Our boilers are very large comparatively, and hold a great deal of water; the engine may stand an hour or two, and will not boil down the water; therefore there is not the same risk on a railway. More than that, we have a tank with a great deal of water to supply them in case it is wanted.

That you carry with you?—Yes. There was an explosion in Scotland from one of those, which was said to be by the breaking of a wheel. I do not see how that would make the boiler explode. I believe the boiler burst, and broke the wheel, and they merely made that excuse.

That was a large boiler?—One of the pipes, one of Gurney's construction; I think I saw it in Scotland; I saw it repairing; I understood it to be the same engine, but Mr. Russell took it up.

You saw an engine which was stated to be on Mr. Gurney's principle that had burst?—No, before this engine burst; I understood it was the same engine, if that which has been shown me was it.

Do you conceive a boiler can be constructed so small as to do the work required of it on a public road, and at the same time not to be dangerous if it bursts?—No; I think if the boiler is made very small it will not do sufficient work to work the engine forward at a desirable velocity.

Have you seen these boilers of Mr. Hancock's engine?—Yes, I have; they are merely a number of flat tubes.

The number of flat chambers is very small; if one were to burst would any evil arise?—No, I do not think there would be much evil from one of these chambers bursting; there is not that quantity of explosive matter to make the same injury; it might injure the individuals near it, but it would not do much damage.

You conceive, for security to the public, boilers must be limited in size?—Of course. I do not know that there will be any means of guarding against danger by testing the boiler, which would be perfectly safe if it was always certain that the water was always

kept at a certain height, but if not there is no safety in testing; they might test before they went off, and before many miles the boiler gets too low, and the material becomes in a very different state? therefore testing ceases then to be of use.

That testing does not meet the objection you mentioned before of the hydrogen gas being generated?—Certainly not.

The only security to the public would be, that the chambers should be so small that if it did burst no injury would arise?—Certainly; each of them should be so small that it would not do much injury if it did burst.

What should be the limit of the size of these chambers?—I could not go into that without consideration.

You know the nature of Mr. Hancock's mechanism?—Yes.

Do you think there is any danger attending it?—I think there is not much danger.

Do you know Mr. Gurney's patent?—Yes.

Do you think there is danger attending that?—There is not so much danger in the tubes if they are kept small, but then you cannot generate sufficient steam.

You think there is no danger?—Yes; I think there is more danger in Mr. Gurney's than in others, for there is a greater quantity of steam held in the pipes than what is held in the chambers of Mr. Hancock's.

What is the danger, explosion?—Yes.

Do you think pipes of that size, if they exploded, would injure the passengers?—If there is a long continuation of pipes connected with it, I think that will so far hold good in Mr. Hancock's; if they are so connected that the connexion will give a free outlet from the other chambers, it is still objectionable.

Are they so?—No; there must be a connexion to get the steam generated; I do not know the size of the apertures. I know if one or more tubes gives way in locomotive engines of an inch and a half or two inches in diameter, it does not do much injury; they stop the two ends up, and go on again. I do not think they can do that with Mr. Gurney's or Mr. Hancock's.

Have you ever travelled by Mr. Hancock's or any one of the steam carriages?—No; I saw one down here, and I stopped to see it go off.

Did it make much noise?—No, I think it did not.

As much as one of your locomotive engines?—No; ours gets the steam off into the chimney; by that we get power to send us along; if they get power in the same way they would go faster on the roads. It is that jet that occasions a noise like the barking of a dog. They do make use of something in the road engines, but it is muzzled, so that the noise does not escape; they must always make use of the outlet through the cylinder to force the current of atmospheric air through the fire, but they muzzle it so that the noise is not heard. Our engines are from twenty-five to thirty horse-power, and those on the roads are not more than three or four horse-power. I am not quite aware, though the power may be great to begin with, it may be soon got rid of so as not to be power at all. It is not fair to calculate power by the size of cylinders. The question is, can they keep it up; if they could keep it up at the rate it set off, it would be a fair calculation to measure from the cylinder; whereas they frequently stop to allow the steam to increase the strength, then the boiler is not sufficient to supply the steam.

Do you understand that to be the case?—Yes; that one that came to Liverpool was a long time on the road, but it stopped very often.

And was assisted sometimes?—Yes.

What is the size of the chambers you make use of on the Manchester and Liverpool railway?—They vary from one inch to an inch and a half, and others have two inches.

In diameter?—Yes.

Not larger than that?—No; the first we put up was three inches; that was the Rockte, the first swift engine; we found that we could make more steam by diminishing the diameter, and getting more (and we got more) surface, and we had them of less diameter since.

Was there much smoke from these engines?—No, I did not see much.

As much or less than the engines on the Liverpool and Manchester?—It must be the same, for they both burn coke; if they burn coke they must have the same proportions.

You do not think there is any means of diminishing the smoke?—I know of nothing better than coke; there are still fumes; a quantity of sulphur comes off.

That offends the nose, not the eye?—It has an effect on the eye also.

It surely makes a very considerable de-

gree of smoke?—If well coked there is no smoke.

But on the Manchester and Liverpool?—Some parts of the coke is not well coked; but if it is properly done there can be no smoke from it, but fumes; there is a decomposition of the air passing through; what comes out must be different from what goos in.

Is it visible to the eye?—No; even the steam is not visible at a temperature of eighty or ninety degrees.

That is on a very hot day?—Yes.

You have turned your attention a good deal with locomotives-engines, to prevent the flying off of sparks from the ash-pit?—Yes, I have tried that, but have not succedeed in it yet.

You could not say if Mr. Hancock's is less?—If his blast is less it will not make so many sparks. I think the ash-pit may be managed; I think that may be so boxed in; it will be injurious to the making of steam, but still it will affect the engine. The freer the air gets to the fire, the more steam will be made at a less expense.

You have not done it on the Liverpool and Manchester Railroad?—They have had boxes, but they are obliged to open at one end, and when the cinders drop out they fly out of the box, and then if they come in contact with the wheels, the wheels moving at such great velocity sometimes throw it a considerable distance.

The sides of the railroad are frequently burnt?—Yes.

You have had one or two serious accidents with fire?—That is since I left the Liverpool and Manchester.

You had one in the north, on a railroad you were concerned with, had you not?—There was a little farmhouse and building set fire to and burnt down.

Are you aware of the particular circumstances of the case?—I am perfectly sure of that being the case.

Do you know at what time the engine passed, and what speed the engine was going?—No, I do not know.

The danger of course is great with a thing of that kind in proportion to the speed at which the engine is going?—More sparks get out at a higher velocity than at a lower velocity; the draught is increased as the velocity is increased; but it is not increased by passing through the air, but by the greater quantity of steam being jetted into the chimney, which forms a vacuum. In the chimney a pipe stands up like the jet-pipe of an extinguishing engine, and all the steam that is required to supply the power of the engine has to pass out of that jet-pipe. It moves at such a velocity, it drives all the atmospheric air out, and leaves a vacuum below. There is no opening to fill up the vacuum, only through the fire, and of course we get the weight of the atmospheric to pass through the fire. In looking through the hole in the door I have seen the fire as if it was dancing on the bars, the current so strong as almsst to lift the cinders, and many of them were brought out through the pipe and up the chimney.

Is there more effect of that kind in windy weather than on a still calm day?—Of course, if the wind is blowing laterally to the train of the carriages it will.

Does it make the draught more rapid?—No, it has no effect on the draught.

You have not tried to make gauze or wire covers at the top of the chimney?—Covers we have; and we have tried various sizes, so as to keep the sparks in and let the vapor out; but it has been all useless. I have tried it at various sizes till I have been obliged to take it off, the engine was so diminished in power; it was injurious to keep it on.

You saw Mr. Hancock's engine; had he any precautions of that kind?—That I do not know; I have not seen that part of his engine.

What is the usual weight you carry in one of your trains; your passenger train?—Forty or fifty tons; no, not more than thirty to forty tons, carriages and passengers together. We have engines now made that if they were travelling on a level road we could take 400 tons; they will take a large ship-load of goods at once, at fifteen miles an hour; we can make them take 400 tons on a level. I would engage to make one of 100 horse-power to move on a railway; we have made them at 50 horse-power, and have sent some of the same power to Belgium, and, I think, some to America.

You think that you are not yet arrived at that point that you can do any good with a locomotive-engine, effectually guarding against any sparks dropping out or flying out from the chimney?—No we have not, certainly; from all I have done and seen it has not yet got to that state.

You were understood to say according to the velocity you go those sparks were carried

to a considerable distance if they met with the wheel?—That is from the ash-pit; the sparks from the chimney are guided by the wind; if the wind is blowing longitudinally with the road the sparks do not leave the line of railway so much, but if the wind blows at right angles the sparks are carried to a considerable distance. The sparks from the chimney of a locomotive-engine are not like the sparks from a common chimney that is on fire. You frequently see a chimney on fire, and sparks come out; these have not the same tendency to ignite; they are so light that when they fall to the ground they are almost extinguished, and combustion ceases. But those that come out of a locomotive chimney have more weight in them,—they are cinders, and there is a quantity of heat remaining in them.

If there were a cap in the form of an umbrella, and they were thrown back into the chimney across, would bad consequences arise from that?—It would diminish the power of the engine; that has been tried; it was one of the schemes resorted to on the Liverpool Railroad by putting a kind of umbrella so that the sparks should be thrown downwards; and it diminished the power of the engine.

Suppose you had a lateral outside chimney, made of very fine wire, so as to carry the sparks down that, and let them fall on the ground?—I think such a covering might be made, only it would be very large and cumbersome, yet it might be made so as to prevent sparks getting out, except of very small dimensions; but it must be very large and expensive to keep up, and it would be destroyed; the free outlet of the chimney would be obstructed, and the power of the engine so much diminished, it could not travel with velocity. The sole power of the engine depends on the exhaustion of the steam into the chimney; if it was only the height of chimney, the draught, without the blast-pipe, would be so much diminished as to reduce a 50-horse power engine to not more than 2 or 3-horse power.

With regard to the power of stopping the engine on the road, in what space do you conceive you could stop an engine going at full speed on a common road at fourteen miles an hour?—I should think from fifty to 100 yards; it depends on the weight and the momentum. The only means made use of in stopping them suddenly is preventing the wheel revolving by the application of the break, and reversing the power of the engine, so that the wheel becomes a sledge, and brings the revolving motion into a sledge motion. It is this sledge motion that takes up the momentum. It requries some calculation to know how soon. The weight of the engine must be given, and the velocity and the friction taken, to state at what distance it can be taken up; it depends also on the state of the road. If it is very wet weather it will not be taken up in the same time as if it were dry. When it is icy the sliding motion would allow the carriages to move forward with as little friction as the revolving motion, which is well known in those countries where dogs are used for drawing sledges through the snow, so that it amounts to a railway; in such cases a sliding wheel would not stop them so soon.

Do you think a weight of three tons could be stopped as easily as a four-horse coach, and in as short a space of time?—I do not think a four-horse coach could be stopped at much less than fifty yards, going at fourteen miles an hour. I think the engine would be as powerful in stopping the carriage as the horses, but I cannot conceive a four-horse coach travelling fifteen miles an hour would stop in much less distance than fifty yards. I think the horses would have a little advantage in throwing their weight against the momentum of the carriage.

How soon could you bring up an engine, travelling ten or eleven miles an hour, on a common road in summer-time?—I should think about forty yards, going at ten miles an hour. I judge from what I have seen frequently done, when a coach is called to stop it does not stop immediately.

You find great difficulty on the railroad in turning, do you not, in taking a short turn?—We do.

That is one of the points in which the system is chiefly deficient?—Yes, the power is very much diminished indeed if the curve amouts to above a certain ratio; a mile radius is the standing point we have got to; we endeavor to keep as near to that as we can. The wheels of the carriage are made conical, so that when we do come to a curve, the larger part of the wheel goes to the exterior rail, and makes up for the extra distance, so that in some degree we manage it in that way; still there is the momentum to be retarded in its progress. All matter put into certain velocity requires a certain power to change its position.

You have on the railroads things that turn to chenge the direction of the engine?—We have; but that engine must be in a standing position.

You never venture to turn an engine except in that way?—No.

Do yon conceive that in these steam-carriages it would be possible to turn round the corner without stopping the engine?—Yes, they certainly can turn better than we can do, they have a swivel motion in the under part of the frame that they can turn it like a gent'eman's carriage. It would be dangerous to have railway engines so constructed. In our engines if the wheels are left to get out of square, that is, if an obstacle is on one rail when moving at a great velocity, if the wheels are left to swing round as the wheels of gentlemen's carriages, the wheel that struck the obstacle would be retarded in its progress, and the engine would turn round and go off the road.

The difficulty depends on having the rail to run on; but it would not exist on the common road?-No; they can be mnde to turn on a common road something like a gentleman's carriage; but that cannot be made use of on a railroad at high velocities, from the circumstances I have stated; that is, from the construction of the engines. Neither can loose wheels be made use of; the wheels in our engines are always made to revolve with the axle-tree, so that when the wheels are made to work in a square frame they cannot change their position. If an obstacle happens to be on the road, and one of these wheels comes in contact with it, the other wheel assists in getting over it, for they all are confined in the direction of the rails. There is a contrivance I saw the other day for passing round curves, but it is by having a centre tc move on, so as to change the direction of the wheels to suit the curve like a gentleman's carriage. I thought it would not do.

That would not be safe?—No; nor could machinery be attached so properly to it; we frequently, with powerful engines, connect all the four wheels together; you cannot do that if they move on a centre.

The result of your evidence seems to be, that you think testing no use?—I do not think it is; it might be of some use; but it would not be so useful as to prevent danger from what I have stated.

And you are of opinion that there would be danger of a boiler bursting if the chamber were above a certain size?—If they are connected together; it depends on their connexion. Our pipes are not connected together; therefore it is only that one aperture which gives way, and allows the steam to escape.

In your engines you use a pipe of what diameter?-Varying from an inch to two inches diameter.

Should you think a pipe of any larger diameter dangerous?—As it increases in diameter the danger must increase with it.

Whereabout does the danger commence?—I think at three inches diameter; I think if it gets above that it will become dangerous; dangerous at three, but still more as it increases in diameter.

You do not think any mode has been yet devised that will prevent the escape of sparks from the chimney?—I think not, not without diminishing the power of the engine.

In engines of large power?—Of course engines with smaller power will have chambers of smaller dimensions, and the same covering put in small engines will affect it in proportion as it will in the large one.

Is there any mode devised at present of entirely preventing the fall of ashes into the ash-pit?—Nothing more than what I have stated.

Without injury to the power of the engine?—I think not; not that I am aware of.

MR. ALEXANDER GORDON, C. E.

Thinks that he is quite an impartial person as regards the merits of the different carriages. Believes that several steam-carriage inventors say that he is partial, but as almost the whole of them say that, considers it as a proof that he is not.

Have you travelled by all those carriages that have been going?—I have travelled by Gurney's, by Macerone's, Hancock's, Field's, Ogle's, and Russell's, and others.

What speed do you think those steam-carriages can travel upon the road?—I have travelled at a speed varying from two miles to fourteen, fifteen, and sixteen, and I have gone a mile at the rate of twenty.

The average rate, taking a good road without any peculiar feature belonging to it, would be how much?—Varying from ten to fourteen would be the rates at which they could travel with most profit.

And without danger to the public?—Yes; they are perfectly under command.

In what possible space can you stop one of those carriages?—Certainly in a less space than a two horse coach.

What do you conceive is the greatest capacity which is consistent with safety?—I should not like to give a hasty opinion upon that. It is a difficult subject to touch upon. I should prefer not to use a chamber larger than that now before your Lordships, and used by Mr. Hancock; nor if I were to use one of Mr. Gurney's should I use one larger than that he has at present; nor would I travel with such a carriage as Russell's boiler, which was attended with the accident near Glasgow; it had a large chamber.

You cannot state what should, in your opinion be the extreme size of the chamber of a boiler? If the chamber of the boiler be cylindrical, I think eight inches or ten inches at most, but I understood the question to refer to a clause in the bill now before your Lordships. In that bill there is a prohibition, I understand, of certain rectangular figures.

What is the proper shape for the chambers or compartments of boilers for these carriages, and of what size may they be made consistently with the safety of the public?—To transmit heat from the fire to the water in the boiler, so as to generate steam of the requisite intensity, a certain surface of the boiler, on which the fire and heated gases play, is necessary; this surface must bear some proportion to the quantity of water to be evaporated. The requisite quantity of surface was in the early steam-engines obtained on the outside of the lower portion of the boiler, which therefore required to be of large size; subsequently the boiler was diminished, and the requisite quantity of surface preserved by directing the flue through the water in a large pipe. Steam-boat boilers required to have still more of these flues from the furnace to the chimney, so that these boilers might expose the smallest weight of water to the largest heating surface. Railroad engines required a still greater proportional reduction of water to obtain lightness, and a still greater proportional heating surface; this was obtained by multiplying the number of flues through the water from the fire-place to the chimney; the flues were reduced in their size, and more of them (sometimes 150 small tubes) were caused to pass, carrying the heated gases and flame through one large chamber in which the water is contained. Such is the general description of railway boilers now in use: they have each one large water and steam-chamber surrounding the fire-place and flues; they are erroneously called by some, tubular boilers, whereas they are large chambered boilers with tubular flues. The material difference between the boiler just named and the small chambered boilers of Gurney, of Dance and Field, of Hancock, and of Maceroni, and of a few others, is that the fire-place and flues in these latter form the large chamber, and the water in small chambers, in films or streams, is presented to the heat in the large oven or furnace. These numerous small chambers of water and steam are safer than the large chamber of water and steam, because the fracture of one of the small chambers does not involve the danger of an explosion of the whole. The ingenuity of the inventors is seen in the arrangements of the tubes or chambers, so as to allow the contained water to receive its heat from the fire, and to part with its steam unmixed with liquid (i. e. dry steam) to the engines. Hancock's boiler may be considered a number of small rectangular boilers, ranged beside each other,—as books in a library,—and connected together, in each of which circulation and separation are required to go on: Gurney's boiler is a number of small tubes in the fire; water sweeps along them, becomes heated, and rising into a chamber or chambers out of the fire the steam is separated from the water, and ready for the engines, whilst the water (with or without an addition to replace evaporation) returns by another channel to sweep again through the small heated pipes. The boiler of Sir Charles Dance and Mr Field is very similar to that of Mr. Gurney. Of the boilers which have been used on turnpike roads some are circular in the cross section of their parts, others are nearly rectangular in the cross section. The circular is known to be, according to both theory and practice, stronger than any other figure. Were it necessary I could give your Lordships numerous instances which occurred to me during many years' practice, with some thousands of my father's portable gass re-

servoirs, at a pressure of 450 lbs. on each square inch. The repellant and fluent particles of steam force outwards in radical lines, and their force is best resisted by hooping them in, all round, the forces are then equal, and they are resisted by the absolute strength of the metal or the resisting force of cohesion. If, however, we confine steam in a square box, or other straight-sided figure, we expose the metal on the straight side of the box to another kind of strain,—the greatest strain to which metal can be exposed,—the power of the steam tending to break the metal transversely; the box is forced by the internal pressure to alter its shape, and bulges out; the metal is crippled, and fracture takes place, generally near the angle, the portions of metal on the same plane performing in some degree the functions of levers. Of the two shapes there can be no doubt the circular is incomparably the stronger.—With regard to the size of chambers of such boilers as are to be allowed on the turnpike road, I think that until some means of preventing explosion, not yet known, are introduced, no cylinder of greater diameter than eight inches should be allowed in such boiler or steam-generator for the turnpike road, and no ractangular or other shaped figure of such boiler or generator shall be of more than forty-nine square inches of transverse sectional area, and no vessel or compartment of such boiler should be made in part or wholly of cast-iron. I have in this answer specified the area of the rectangular figure, which is equal to the area of the circle, eight inches diameter, not because the rectangular figure in any measure equals the circle in strength, but because if an explosion does take place the same amount of steam and water may be presumed to escape. I believe, however, the area of the fracture would in case of accident always be the largest in the rectangular figure.

Inform the committee of the weights of stage coaches, vans, waggons, and steam coaches, with the view to levying a toll on the latter; and also of the probability of steam conveyance being more general on the turnpike road or on the railroad?—Of these conveyances the most destructive to the road are the light stage coach and mail coach. In them there is a greater proportional weight resting on a square inch of the tire than there is in any of the other conveyances above stated. The difference in the rates of travelling is of less consequence; of the proportional damage done to the road surface by horses feet at a quick or at a low rate, I do not know that any experiments have been made; and in my opinion the damage done by a steam-carriage and load to the road is certainly not one-third part of the damage done to the road by the mail or stage-coach and its horses, the weights moved being in both cases the same, and, after long and careful examination and experiment, I should say, that were I the proprietor of a road I should prefer the steam-carriage, even of six tons weight, as the least destructive; and having special regard to the interests of the road-trusts of the country I say the same.

	Rate in Miles per hour.	Average Weight in Tons. Coach and Load. without Horses.	Observations.
Mail or stage-coach	8 to 11	$2\frac{1}{2}$	Average weight of each Horse in any of these Conveyances may be stated as Ten Hundred Weight.
Van	$6\frac{1}{2}$	$4\frac{1}{2}$	
Six-horse waggon	3 to $3\frac{1}{2}$	$4\frac{1}{2}$	
Eight-horse waggon	3 to $3\frac{1}{2}$	6 to 7	
Steam-carriages	7 to 14	2 Tons.—Some are much heavier. I have seen one Six Tons weight. The best amongst many that I have seen and travelied by was not Three Tons.	

MR. THOMAS HARRIS.

Was the engineer who superintended Mr. Gurney's steam-carriage while running for Sir Charles Dance between Gloucester and Cheltenham.

While you were running between Gloucester and Cheltenham, do you imagine that was a profitable speculation to Mr. Gurney?—I do not know; there was a great expense in establishing coach-houses

and buildings, and the time was not long enough, I should think, to refund. I think we could have done very well.

Do you think the traffic on the road paid the expense of carrying it on?—Yes; it cleared it well.

Would it pay the expense of carrying it on in London?—I have not a doubt it would.

Then it is not from the extent of tolls you were prevented from doing it near London?—I believe not.

Do you know for what reason Mr. Gurney did not continue?—It was a matter of choice on the part of Sir Charles Dance.

REV. MR. WILLIAMS.

You can give evidence as to steam-carriages?—Yes; I have rode on them more than any person in England. I am a great advocate for them.

You are an amateur traveller in them?—Yes; and I understand something of the mechanism as well. I know something of the construction of all that were built in London.

Have you ever travelled by Gurney's carriage?—Yes.

Do you know the nature of his machine?—Yes, it is a tubular boiler.

Can it be used on roads with safety to the passengers?—The fact is, his boiler is safe, perfectly safe, but he has got an appendage to this boiler which is called a separator, or, as I call it, a danger-chamber, in order to separate the water from the steam. Within the tubes the steam forms, as it were, a corkscrew or coil, and brings out the water with the steam before it passes to the cylinder where the piston is. In order that the steam should be efficacious he has got the separators, and these are of large capacity; the consequence is, it does not signify whether the boiler is tubular, spherical, or of any other construction. If you bottle up that steam, they are all dangerous, which is the case with Gurney's; it is a dangerous boiler as long as there is a place of capacity for the steam, for if that steam is not passed off to the piston that works in the cylinder up and down, or horizontally, it you do not pass it off immediately it will burst any thing, whether it is a sphere or whatever other shape.

That separator is peculiar to Gurney's?—Yes, I think so.

You think that it is productive of danger?—Yes.

Have you been by Gurney's carriage?—Yes; several miles.

Have you met with any accidents?—No.

You trusted your life in it, notwithstanding your knowledge of the danger?—Yes; knowing that the engineer, Mr. Stone, made his valve only to a safe pressure; but suppose you come to a depth of gravel on the Cheltenham-road, eight or nine inches thick; the depth of the gravel was rather more than is usually laid by trustees on roads; it was not enough to impede a mail-coach, but it impeded his carriage, and the consequence was that they used a very great pressure there to get over, but with it the axletree broke.

Were you in the carriage at the time?—No.

You were not one of those who were blown up?—No.

Therefore danger did not occur?—No.

Have you known a case where it did occur from the boiler bursting?—Yes, at Glasgow; it was Gurney's carriage, sold to a person of the name of Ward; their carriage was in a coal-wharf at Glasgow; the person who had the management of it put on the steam, and was going to show it off to great advantage; the steam was so powerful, that either the separator or the boiler burst, and a boy or man was much injured.

Was there a separator?—Yes.

Did you see that?—Yes.

Was not that a carriage with a large chamber?—Not much larger than the usual chamber.

Was it not with a large square chamber hung under the carriage?—No; I think a cylindrical one.

But the one that burst?—Yes; I have rode on them likewise; the Scotch carriages; I have rode on it 300 miles.

But keep to Mr. Gurney's carriage; was that it? (*Pointing to a drawing.*)—No, that is Russel's; here is the boiler, which is of large capacity, and would not bear a pressure of above 35 to the square inch. I rode in this from Hammersmith to London scores and scores of times, knowing they never worked at a pressure of 20 or 25, therefore it is safe, though it is a boiler of large capacity; the safety depends on the engineers; they may blow up any of them if they load the valves to more than

they can bear; but it can be prevented by a lock-up valve.

You think all steam is dangerous?—Yes; it depends on the engineer employed if he has the sole control of the valves.

You venture on board steam-packets?—Frequently; and I consider them more dangerous than steam-carriages, having boilers of great capacity, containing thousands of gallons.

Then you are an enemy to steam in general?—No; it depends on the engineer entirely; if he is fool-hardy enough to use higher pressure than a boiler can bear, no carriage is safe.

Did you ever travel by Mr. Horne's stage-coach?—Yes.

There your safety depends on the coachman?—Yes, and on the management of the horses entirely, and the coach-builder; if the axletree breaks, or a spoke or spokes break, you must come down, and most likely dislocate a limb, or lose your life. I should rather a steam-coach for travelling on, if one safety-valve is locked up from the engineer, than the best-conducted horse-coach that I know of. I do not consider boilers without the steam-chamber at all dangerous; but if they have got such steam-reservoirs, they are dangerous.

Go back to this carriage of Mr. Gurney's that burst at Glasgow; when was that?—I cannot recollect dates.

Who was the proprietor of it?—A person of the name of Ward, a man who lost a great deal of money speculating in Gurney projects, like many other gentlemen that advanced money in his concerns, to the amount, I have been told, of 40,000*l.*—This is Russel's carriage (*producing a drawing*); an advocate in Edinburgh, a Mr. Dauney, a friend of mine, lost 10,000*l.* by embarking in it.

Do you know Mr. Hancock's carriage?—Yes; I have rode in them upwards of 4,000 miles; the reason why I did so was, he was continually working on all roads, winter and summer; the prohibitory tolls had nothing to do with his carriages; *he could go distances on roads where the Acts had not been renewed, the same as Mr. Gurney might have done if he had been in a situation to run.* In the metropolitan districts the Acts were renewed, and applied to steam or any other power; but the expenses attached to that are not prohibitory; it is 4*d.* on his carriage instead of 2*d.*, being double tolls in proportion to omnibuses.

Do you think the tolls were prohibitory in the other places?—Yes; but Mr. Hancock did run thrice from London to Brighton, and paid no tolls at all.

Do you think his carriage is dangerous?—No; he has no steam-chambers. An accident happened in his factory; a part proprietor in one of his carriages tied down the safety-valve with a coil of wire, so that it was impossible any thing could bear the pressure; a rend seven inches long took place; he was not hurt, but paralysed from fright, the surgeon said. There has been no serious accident from any steam-carriage of Mr. Hancock that I am aware of.

Not any whatever?—No, not on the roads, never an accident while going.

Did you ever hear of the Birmingham carriage?—Yes, but on turnpike-roads. I rode in that carriage, (*pointing to Squire's and Maceroni's,*) which is a very excellent carriage; I have rode from London to Uxbridge and back, to London twice, and also in Ogle's several times.

The result of your opinion seems to be, that they are all dangerous, but that no accident happens?—If the engineer is a fool-hardy fellow, it is dangerous. I have rode 200 miles in one, and I have rode in Mr. Ogle's carriage 100 miles; now his carriage is as fast as any of the carriages, and as safe; I do not think he has a steam-chamber; the boiler in his carriage is composed of a tube within a tube, and caloric impinges on the water inside and out; he generates steam as fast as the engines require it, which is the case with Mr. Hancock's, I do not think any of them are dangerous, provided the engineer is not intrusted with the key of one of the safety-valves.

MR. WILLIAM CUBITT, C. E.

You were one of the party of engineers who subscribed towards the building of a locomotive carriage by Messrs. Maudslay and Field?—I was. It originated in a sort of challenge which I gave the parties to prove the possibility of doing the thing.

What was the result of the acceptance of that challenge?—The result of it was that a carriage was built, and remarkably well built; it travelled exceedingly well, and

was very manageable; *it proved that the thing was perfectly practicable*, but was not economical or expedient to be applied to the purposes of traffic.

Can you state to what extent it was not economical?—It was not economical in this respect, inasmuch as the expense of the machine and the expense of keeping it in order was too great to be put in competition with railway travelling or even with common roads. Such, at any rate, was the result, in my judgment, from the experiments we were enabled to make.

In what respect did the inexpediency of it consist; was it in travelling?—It was on account of the great cost of it.

Did you not draw a distinction between the two; expediency and economy?—I intended to say it was not expedient because it was not economical.

Has it no other disadvantage?—No; the thing is perfectly practicable; there is no difficulty whatever in making a good carriage which will travel remarkably well. We have gone up steep hills with the one we had in Dulwich and the neighborhood, but the great cost is against it.

Is it not dangerous to the passengers?—Not under proper management any more than any other machine.

Do you mean than any other coach?—Yes.

Is it not dangerous to the people on the road by frightening the horses?—Not at all; I have been frequently through crowded roads in the neighborhood of London and I have never seen the horses frightened.

What was the weight of it?—Between five and six tons.

Was that as light as could be made?—It might have been made a little lighter.

Did it do much damage to the roads?—Not the least. I think if it were made properly it would rather mend the roads than otherwise, inasmuch as the wheels must be broad wheels, and cylindrical, and therefore they roll the roads.

Have you ever seen Mr. Gurney's steam-carriage?—Never.

You do not know any thing about the contrivance of that?—No. The contrivances are all on one principle; the great object is to contrive a boiler which will combine lightness and a capability of giving a great quantity of steam.

In your opinion they are not so economical as stage-coaches?—They are not so generally useful or economical as stage-coaches, because there must be an immense establishment to set them going; to run from here to Bath would require a great many locomotive carriages, and a vast establishment of workshops and stations? in fact under such management as railway carriages, which would be attended with much more expense.

What was the cost of yours?—One thousand guineas, by agreement.

What was the size of the boiler?—Our boiler was a boiler of peculiar construction; it was an assemblage of tubes, and I believe it was on the principle of what is called Gurney's boiler; at least I think so.

Who directed the form of the engine?—Mr. Field himself, subject to the approval of myself and one or two other engineers.

And you all came to the conclusion you have stated: it was an unanimons opinion was it?—I do not know that it was unanimous; we never met to express an opinion upon the subject, nor do I know what the opinion's of the other parties are; I do not even know what Mr. Field's opinion is, whose judgment I should most rely upon. I made six or seven journeys, and the result of my experience was that it was practicable but not expedient, because it was not economical.

From the experiments you have made are you satisfied that more economy could not be introduced in the management of steam-carriages,—that they conld not be conducted sufficiently economically; have you made sufficient experiments to satisfy yourself upon that point?—I can only speak from the experience I have had; I doubt they could be conducted economically except upon such an immense scale as it would be impossible to establish; for instance, it would be impossible to establish a steam-carriage—to have one or two steam-carriages running from London to Bath, it would cost more than it would be worth, and they could not take passengers in competition with well-managed coaching; they could not do that but by the investment of immense capital, having an immense establishment, and doing every thing upon a very great scale. It would be necessary perhaps to have a hundred steam-carriages to keep a concern continually going.

Is not the formation of a large capital perfectly possible ?—It is.

Are not railways conducted by companies ?—Yes, they are ; but there is not the difficulty attending the construction of a railway and the management of carriages on railroads that there is with steam-coaches ; we require a totally different class of persons. In a railway a man of comparatively common talent will do for what they call the engineer, that is to manage a locomotive engine ; but in managing a steam-coach it is quite different, there is the greatest presence of mind required, he should be a person of great sharpness and firmness to manage a steam-carriage on a common road ; we were fortunate in having a very able man at the time we made the experiment ; he was a man of the greatest nerve and spirit, and he was also a person of great mechanical skill ; it made us all nervous sometimes to see him steer through a string of carriages in the way he did.

Have you ever made any calculation as to the difference of speed between what could be accomplished on a common road and what could be accomplished on a railroad ?—No ; but I should say I scarcely know a limit to the speed that could be obtained upon a level and good railway ; I should say there is no limit till the power is balanced by the atmosphere, which would be upwards of sixty miles an hour certainly.

MR. JOHN BRAITHWAITE, C. E.

Have you directed your attention to the distinction between locomotive-engines and carriages that run on the highway ?—I have; not that I consider much difference between them.

Are you acquainted with the construction of any of those carriages ?—My attention has been called to them, but not with regard to any particular plan ; Mr. Hancock's and others, Mr. Gurney's and Colonel Macerone's all of them have been experimentalizing for a considerable time, but it does not appear that the result has been what we should call practically successful.

As an engineer well acquainted with these things, do you imagine that the science is sufficiently advanced to enable you to build such an engine as would be both safe and sufficiently economical for general purposes ?—Certainly not.

Do you think there is any danger in them ?—I do not think there is any danger.

Then the objection is decidedly upon the ground of the expense being greater than the profit would justify ?—I should say so most decidedly.

For what railways do you construct locomotive engines ?—At this present moment we are constructing a great many for Cuba, and we have also been applied to by the Birmingham and London Railway Company. The great difficulty is to get parties who will construct them with sufficient care and attention. Some time since I was competing with Mr. Stephenson upon the Liverpool and Manchester Railway with an engine, which was called the Novelty. It was then given as the opinion of many persons that if locomotive-engines cost as much as I asked of the Liverpool and Manchester Directors, namely, 1000*l*., that that of itself would be a decided prohibition to the introduction of steam-carriages on railways; and yet, notwithstanding that, we are now receiving not only 1000*l*., but in many instances 1200*l*., 1300*l*., 1400*l*., and 1500*l*., for locomotive-engines.

How is it that their price is not a prohibition ?—From the circumstance of the great duty which the engines now do, which was never anticipated. At one time it was thought we never should do more than something like twelve miles an hour; but the result was, that we did at the rate of forty-five miles an hour.

Do any of your engines run upon that road ?—No ; I do not choose to build engines after a model which I know to be objectionable, unless desired as a manufacturer ; and as they saddle us with the responsibility of proving these engines, which would necessarily take me a distance of 200 miles from my place of abode, it is rather too far to undertake the management of them.

Have you any carriages running on any existing railway ?—Not at present; we are making several ; but of course, having a very extensive manufactory, we are obliged to make for the market. We are making them upon the model laid down by the Liverpool and Manchester Railway Company,—Mr. Stephenson's improved by Mr. Berry.

Have you turned your attention to the means of preventing sparks from flying out ?—Yes, I have.

Have you, in your opinion, succeeded in effectually preventing it ?—No, I have not.

Have you succeeded in effectually preventing any loss of cinders from the ash-pit ?—Yes ; we have a tray constructed at the bottom part of the grating to receive any thing that falls.

Do they not fall out ?—Occasionally they may do so, when they have been stoking very furiously for the purpose of effecting particular objects, such as getting up the inclines ; then they require abundance of steam, and stoke furiously ; and now and then cinders fall out in spite of the greatest care.

We give the following "Notes on Indiana," believing that they will be found highly interesting to many of our readers.

From the Springfield Ohio Pioneer.

NOTES ON INDIANA.

Mr. Editor,—Having recently returned from a visit through the Northern part of Indiana, and thinking that a few hurried remarks upon that country might not prove uninteresting to some of your readers, I submit the following particulars.

After having made a voyage across the ocean of swamps, extending in width from St. Mary's, Ohio, to Fort Wayne, a distance of sixty miles, we reached the latter place, the country seat of Allen county, Indiana, situated on the east bank of the Maumee river, where the river is formed by the junction of the Little St. Joseph's and St. Mary's rivers, and immediately on the ground where Wayne's fortification against the Indians stood, from whence it derived its name. The population is about 1000 : half of which are French and Canadians. The public buildings are a court-house, jail, and three churches : it has a bank and a library. The land office is kept here. The river is navigable for barges and keel boats ; and lately a small steamboat ascended as high up as this place ; and from this may be dated a new era of its prosperity. The Wabash and Erie canal passes through this place : twenty-five miles of it is furnished from here to Huntington, and affords an extensive water power at this place. In short, Fort Wayne is situated in the midst of a rich and fertile country, which, together with its other local advantages, must make it in a few years become a thriving and populous city.

After crossing the rich and fertile counties of Noble and Elkhart, with their many advantages, in a North Western direction, we came into the county of St. Joseph.—South Bend, the county seat, is beautifully situated on the south bank of the Great St. Joseph's river, upon a sandy plain elevated about 25 or 30 feet above high water mark ; and contains a population of about 1000 ; and perhaps is not excelled by any town in the North for beauty of situation. It has attained its present importance and beauty by its superior local advantages. Its growth though rapid, has been steady, and corresponding with the improvement of the surrounding country. The town plat was laid off into lots, and brought into market between five and six years ago : a more eligible site could not have been found in all Northern Indiana. Travellers are charmed with its beauty, and upon learning its superior local advantages are at once struck with the conviction, that it must and will, in a very short period of years, become a town of some five or ten thousand inhabitants. The St. Joseph's river, opposite the town, is about two hundred yards in width : it is a deep and majestic stream, and is navigable for steamboats as far up as South Bend, and even further, except when locked up by the frosts of winter. Its course is generally North-West, and a more beautiful and imposing stream was never gazed upon by man. Just opposite the town there is a fine fall in the river, which when properly improved will afford a most tremendous water power. A company of enterprising men are now improving it by cutting a race with a lock for boats to pass through, and furnishing materials for damming the river. It is calculated that a power will be brought under control sufficient to propel from fifty to a hundred run of mill stones. This vast power will be immediately thrown into market : it will immediately arrest the attention of enterprising capitalists, and will, without doubt, all be employed in propelling various kinds of machinery in a very few years. Besides this vast power, there is a race discharging the waters of the Kankakee river into the St Joseph's on the town plat, affording a volume of water sufficient to propel from ten to twenty run of mill stones. There may be some estimate of the power afforded by this improvement when it is made known that the proprietors have been offered the sum of thirty thousand dollars : the whole

improvement perhaps not costing more than three thousand dollars. And here are the waters of the South united with the North —the Lankakee river emptying into the Illinois river, and the St. Joseph discharging its waters into the Michigan lake. Thus water, that was intended by nature to flow into the Gulf of Mexico i , by a little labor, made to flow into the Gulf of the St. Lawrence.

A canal is located through South Bend from Michigan city on Lake Michigan, to intersect the Wabash and Erie canal at Fort Wayne; and it will in all probability be put under contract the ensuing summer. The Michigan road—a graded road—extending from Madison, on the Ohio river, to Michigan city, passes through South Bend. This, it will be readily seen, is an important road; it being the greatest thoroughfare through the centre of the State, from South to North; and towns through which it passes in the interior may boast of it as being a matter of no minor importance. At no distant day, a railroad perhaps from some point on Lake Erie, directly through South Bend, to Michigan city, and thence, in course of time, west to the Mississippi river will be constructed. The project is under way, and the combined enterprise and capital east and west will be enlisted for its prosecution. By reference to maps it will be seen that this railroad must pass directly through South Bend.

The Kankakee river may, with trifling expense, be rendered navigable for steamboats within twelve miles of South Bend. A canal across these twelve miles, will open to South Bend a water communication with the great Mississippi river, and its vast and extensive commerce.

The town is remarkably healthy, and the land of the country around it, is like most of the land in the northern part of the State —open oak and some heavily timbered land, prairies, and low lands.

The soil is of a sandy nature, but mixed with a sufficient quantity of marl and iron, which renders it productive, and is a guaranty of its durability.

The county of St. Josephs, though but six years ago an untamed wilderness, the undisputed wild and uncultivated home of the savage, now contains a population of from five to six thousand enlightened and industrious farmers, and abounds with numerous well tilled, extensive, and productive farms. Possessing such advantages, it is not a matter of wonder that South Bend should have assumed her place among the populous and flourishing towns of the North. It contains two churches, a printing press, from which issues weekly the "South Bend Free Press," a public library, fifteen dry goods stores, and two drug stores; three taverns and four groceries; four lawyers, three physicians, and mechanics of almost all the branches of the mechanic arts; there are, also several week day schools, two sabbath schools, a temperance society, and a lyceum, &c. &c.

About four miles from South Bend up the river, on the same side, is a village by the name of Mishawaka, containing a population of about three hundred souls. It possesses many advantages, and among others, inexhaustible beds of iron ore near it, which is going to be worked by a company of enterprising capitalists, during the ensuing spring. They are making hasty arrangements for a furnace, rolling mill, &c., and they have already in operation an extensive iron foundry, a flouring mill, and many other kinds of machinery. There are several large dry goods stores in this little village.

The next places that arrest the eye of the traveller, are Laporte and Michigan city, both of which are situated in Laporte county. The town of Laporte, the county seat, is situated near the centre of the county, on the south bank of a beautiful clear lake, of about a mile square; it is bounded on the east, south, and west, by extensive and beautiful dry prairies, and natural meadows, which are mostly all fenced and under cultivation, and dotted over with farm houses. On the south-west, the scenery is beautiful in the extreme, there being no forest or in exceptance of the view, till the horizon and the earth seem to close. Nothing can be more charming than a view of this in autumn, when the sun is declining in the west with all the splendor of an autumn afternoon. Laporte has a population of from five to seven hundred. Its public buildings are a court house, a jail, and two or three churches; it has also, a library and a printing press, from which is issued weekly the Laporte Herald. The land office for the Laporte district is kept at this place.

Michigan city is twelve miles from Laporte, and situated on the shore of Lake Michigan, from whence it derived its name.

The ground upon which it stands, is very sandy, and uneven, consisting of hills of loose, yellow sand, which was at one day all occupied or covered by the lake water, but the waves have through time thrown up these sandy barriers and caused the Lake to recede for several hundred yards. The population is perhaps about a thousand, who are mostly emigrants from the State of New-York. Its advantages consist entirely in its being a landing place for vessels of merchandise for the interior part of the State. There is no harbor as yet at this place, but the citizens are making arrangements for constructing one the ensuing summer. The country immediately around is mostly broken, and of a poor sandy soil, covered mostly with white pine timber, which affords excellent building timber. It is not more than three or four years since this place was laid out. Its growth has been very rapid, and bids fair to become one of the foremost of the towns on the lake.

Much more might be said of the rapid growth and prosperity of Indiana; but having already lengthened this longer than I first intended for a newspaper arricle, it is sufficient to say that in a very few years Indiana will assume a place in the formost rank of her sister States. H.

From the Railroad Journal.

AVERY'S ROTARY ENGINE.

The constant applications from all parts of the country, for information in relation to this wonderful machine, induces us to give such facts in relation to it as come within our knowledge.

The following letter signed by four genmen, of the highest respectability and intelligence, residing at *Ithaca*, Tompkins county, N. Y., gives the facts and impressions of a short visit to a saw-mill, erected by ABRAHAM BELL, Esq., of Jersey City, and SETH GEER, Esq., of this city, in the midst of a *Pine forest*, in Tompkins county, eleven miles from *Ithaca*.

The accompanying cut is a fair representation of the mill referred to, with the exception of the mode of driving the saws. In the mill of Messrs. Bell and Geer, the saws are driven by a drum to *each saw*, but in this cut, there is but one drum, and the saws are driven by the *walking beam*, as will be seen on referring to the description.

ITHACA, N. Y. Dec. 13, 1836.

TO D. K. MINOR,

SIR,—In compliance with your request, we cheerfully give you our views and opinions of the performance of Seth Geer and Abraham Bell's saw-mill, driven by "*Avery's Rotary Engine*," situated in the town of Enfield, Tompkins county, N. Y.

The simplicity of the Engine, and consequently the ease and facility with which it can be managed by persons of ordinary intelligence, and who would be wholly incompetent to work a piston engine, first excited our attention; and upon a careful examination of the machine, elicited our united applause. It is unnecessary for us to give an elaborate description of the Engine, which is estimated at 20 horse power.

The power is applied to the saw in the most simple manner by bands; the motion being reduced by increasing the size of the drum, so as to give the saw any required velocity. The saw that we examined made 220 strokes in a minute, sawing three boards from a log 12 feet long and 2 feet in diameter, in nine minutes, or cutting at the rate of over 11,50 feet per day, if it could be kept in constant motion—but allowing one half the time to be lost in running the carriage back and adjusting the logs, it would cut from 5 to 6 thou and feet of lumber per day. The mill was arranged for 2 saws, which the workmen assured us they usually kept constantly at work; but the hand to one of the ragwheels having been sent to the shop to be repaired, we witnessed the performance of but one saw. The workmen told us that the power was sufficient for both saws.

The plan for confining the saw without a saw-gate, was, as we were informed, invented by Mr. Mooley, and appeared to answer the purpose well.

It is with pleasure that we assure you, Sir, that we were highly gratified with the whole performance, and with the utmost confidence, recommend *Avery's Rotary Engine* as a moving power for saw-mills.

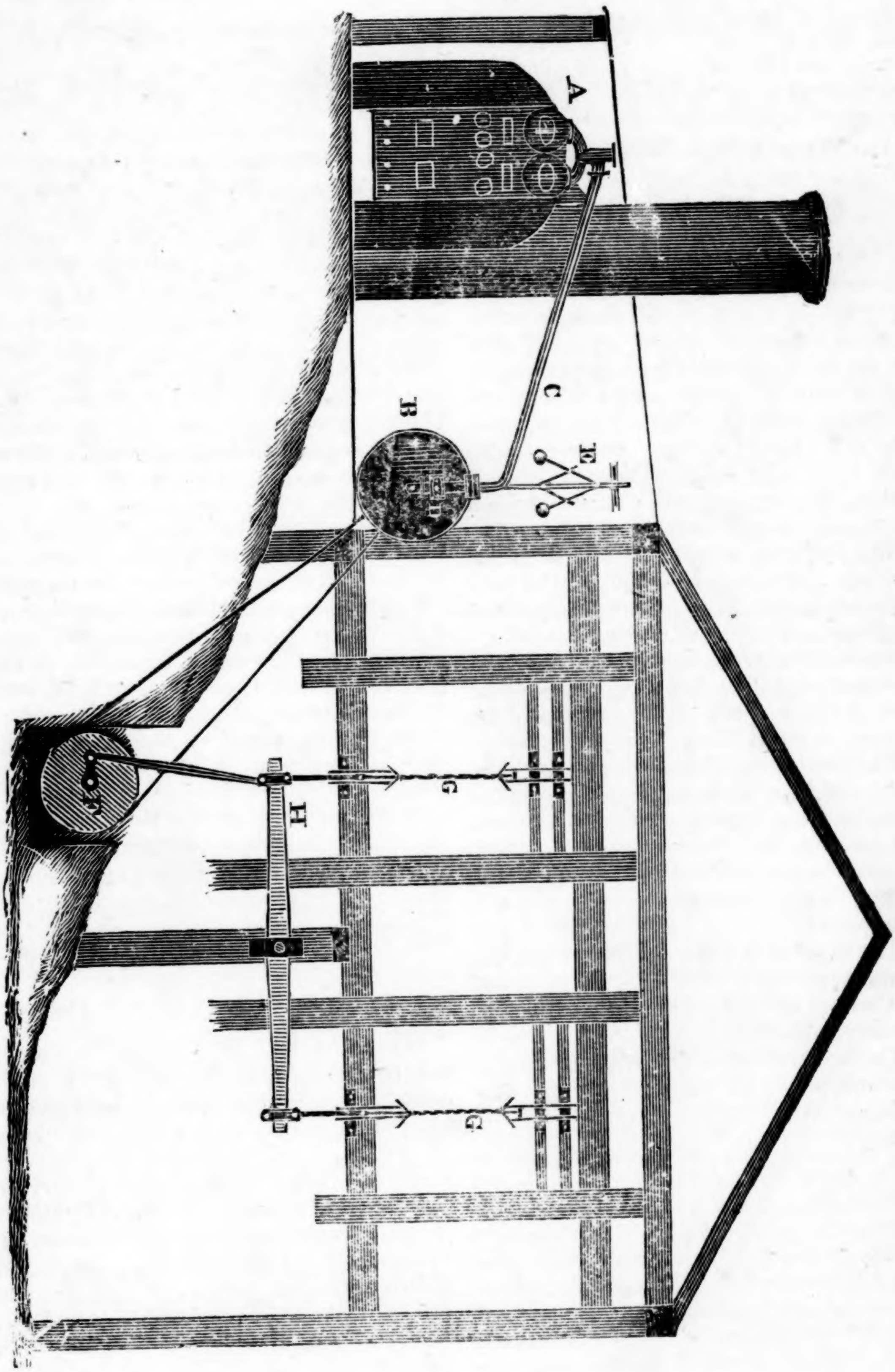
Respectfully,

Your most obedient, &c.,

GEORGE MCCORMICK,
J J. SPEED, Jr.,
HENRY ACKLEY,
HENRY INGERSOLL.

The cut represents a saw-mill with two saws driven by a ROTARY ENGINE. There

may be two *gangs* as well as two *saws.*-- A represents the boiler; B the engine; C the steam-pipe; D the shaft, into the *end*, or *side*, of which the steam passes from the boiler, through the pipe C; E the governor, which regulates the passage of steam; F



the drum around which the driving band passes from the pully on the end of the shaft D. On the end of this drum is a crank for driving the walking-beam H, to each end of which is attached one or *more* saws, as at G, G.

This mill is represented as situated on a side hill, and the drum placed in a pit under the mill.

An *Engine* of this description, without boilers and machinery, to drive *two* saw gates can be furnished for six hundred dollars,—and the boilers, pumps, furnace irons, and fire bars; governor, and *all* the *necessary machinery* up to, and *including* the walking-beam, or drums, for *fifteen* to *seventeen* hundred dollars; or 2,100 to 2,300 dollars for the whole machinery up to the saw, and the same for *one* saw gate will be fifteen to sixteen hundred dollars, delivered at the shop of E. Lynds & Son, Syracuse, Onondaga County, or at the "*Novelty Works,*" in this city, by application to Mr. Joseph Curtis, 132 Nassau-street.

The power of this engine will be ample to drive 1 saw in 1 gate, and *three* or *four* in the other—or to drive *two* saws in the single mill, or mill with one gate.

Since writing the above, we have been furnished with the following statements, from gentlemen who fully understand the subject.

The first is from Henry Seymour, Esq., late—and from the commencement of the Erie Canal—one of the acting Canal Commissioners. Mr. Seymour is himself the owner of a Saw-mill of the ordinary kind, and he fully understands what a saw-mill should do.

The other is from the owners and millers of the new Grist Mill erected in Cayuga County, N. Y., in relation to which we recently published a letter from Mr. Avery.

These certificates are from gentlemen who understand the subject, and they may be relied upon.

Syracuse Jan. 31, 1837,

To Elam Lynds, Esq.

Dear Sir,—I saw to-day the saw-mill in Cicero, which is propelled by one of Avery's Rotary Engines. While I was present, the saw cut a hemlock log of about two feet diameter with ease and rapidity, and appeared to have power sufficient to accomplish much more. The work was well done, and I was well pleased with the power and performance of the engine in all respects.

Yours very respectfully,

Henry Seymour.

Cato, Cayuga Co. N. Y.
January 25th, 1837.

We the subscribers, owners of the Steam Grist Mill at this place, do certify, that the Rotary Engine, that drives our mill, is one of Avery's Engines, and manufactured by Messrs Elam Lynds & Son, and is in our opinion, the best steam power for a grist mill that can be had. It gives us perfect satisfaction, and we cheerfully give this certificate.

The grinding we do is for customers, in grists of from one to ten bushels, and of all kinds of grain, so that we are unable to say how much we could grind in a given time, but this we can say, that the Engine will drive the stones to grind all the grain that any mill can grind with three run of stones, which is the number we have. We have never been able to ascertain the amount of fuel we should require if we were grinding for flouring, or indeed for our present use; but of this we are confident, that with good wood, we could grind more than 100 bushels with a cord of wood. We do not use the full power of the Engine, and it is believed by us and others, that the Engine would drive two run more if we had them, and do good business with the five running at once, without any addition to the Engine or Boiler.

B. Conger.
Henry Furman.

We the subscribers, Millers, tending the above mill, fully agree with the above certificate.

P. D. Livingston,
David Corp.

Width of the Delaware River opposite Philadelphia.—On the 17th of January, 1837, the river Delaware was carefully measured with a four pole chain, on the ice, from the end of the wharf at English's (late Daniel Cooper's) ferry, in Camden, to the end of the wharf at Burr's (Blight's) ferry, south side of Market-st, in Philadelpqia, by Richard W. Howell, and Josiah Harrison, Esqrs., of Camden, and was ascertained to be 54 chainsand 50 links, being $22\frac{1}{2}$ rods short of three quarters of a mile.